NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Bibliography 39-10

Publications
of the
Jet Propulsion Laboratory
July 1968 through June 1969

JET PROPULSION LABORATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

October 31, 1969

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Bibliography 39-10

Publications
of the
Jet Propulsion Laboratory
July 1968 through June 1969

JET PROPULSION LABORATORY

CALIFORNIA INSTITUTE OF TECHNOLOGY

PASADENA, CALIFORNIA

October 31, 1969

Foreword

JPL Bibliography 39-10 is a compilation of official reports of the Jet Propulsion Laboratory released July 1, 1968 through June 30, 1969. Current security classifications of all documents are indicated; however, their titles and abstracts given herein are unclassified. JPL reporting in the open literature is also included.

Jet Propulsion Laboratory reports may be requested by either report or entry number. When ordering classified documents, the government contract under which they will be used should be indicated, and requests forwarded to JPL via the cognizant contracting officer for certification of security clearance and need-to-know. Copies of unclassified reports are available upon direct request to the Laboratory.

Contents

Technical Reports and Memorandums

Technical Reports are designed to report on a single significant development, on the completion of a recognizable phase, or on the completion of an entire project, or may record data or a development growing out of an assigned project but not directly related to it.

Technical Memorandums report the results of a special study of a problem, provide preliminary information on a project, or present any other material which is intended for a limited audience.

Abbott, P. W.

A01 MEASUREMENT OF STRUCTURAL TRANSFER FUNCTIONS SIGNIFICANT TO FLIGHT STABILITY OF THE *SURVEYOR* SPACECRAFT
Gayman, W. H., Trubert, M. R. (Jet Propulsion Laboratory)
Abbott, P. W. (General Dynamics Corporation)
Technical Memorandum 33-389, May 1, 1969
(Unclassified)

For abstract, see Gayman, W. H.

Adkins, J. M.

A02 BASAL-PLANE METALLOGRAPHY OF DEFORMED PYROLYTIC CARBON
Fischbach, D. B., Adkins, J. M.
Technical Report 32-1389, June 1, 1969
(Unclassified)

For abstract, see Fischbach, D. B.

Alexander, W.

A03 THE 10-FT SPACE SIMULATOR AT THE JET PROPULSION LABORATORY
Alexander, W., Dyckman, L., Harrell, J., Nelson, W., Schaefle, W.
Technical Report 32-1231, Revision 1, January 15, 1969
(Unclassified)

This report describes the JPL 10-ft space simulator facility that is used for JPL, NASA, and NASA-authorized testing purposes. The report also provides sufficient technical information for proper planning of simulator tests.

Argoud, M. J.

A04 SAFETY EQUIPMENT FOR HANDLING THE 20-kW AND 5-kW ARC LAMPS
Argoud, M. J.
Technical Memorandum 33-429, April 15, 1969
(Unclassified)

The 20-kW compact xenon arc lamp used as the energy source for the simulated solar system in the 25-ft space simulator has an internal pressure of approximately 4.2 atm (47 psig) at room temperature. At operating temperature, its pressure increases to approximately 10 atm (132 psig). For this reason, safety equipment must be supplied for the men who work around these lamps. Several tests were conducted on various pieces of protective clothing which were exposed to the breaking of quartz envelopes identical to those used in the manufacture of compact xenon arc lamps. Two pyrex tubes and quartz envelopes similar to those in the lamps were broken at 45 psig. Various articles of protective clothing and different types of materials were exposed to the exploding lamp and then inspected for marks and cuts. After much modification, the test was repeated with much improved results. A verification test of face shield and leather gloves was performed to prove safety with a more direct explosion impact. Other tests were also run to evaluate different methods of personnel protection and to establish safety requirements for the 5-kW arc lamp.

Avizienis, A.

A05 AN EXPERIMENTAL SELF-REPAIRING COMPUTER

Avizienis, A.
Technical Report 32-1356 (Unclassified)
(Reprinted from the *Preprint Booklet E (Hardware 2)*
of the 1968 Congress of the International Federation for
Information Processing, Edinburgh, Scotland, pp. E29–E33,
August 1968)

This paper describes an experimental self-testing-and-repairing (STAR) computer which has been designed to serve in further research and in evaluation of self-repair techniques. The description covers the organization, the method of operation, the choice of fault-detection techniques, and the recovery procedures of the STAR computer.

Back, L. H.

B01 HEAT-TRANSFER MEASUREMENTS IN THE SHOCK-INDUCED FLOW SEPARATION REGION IN A SUPERSONIC NOZZLE

Back, L. H., Massier, P. F., Cuffel, R. F.
Technical Report 32-1278 (Unclassified)
(Reprinted from *AIAA Journal, Vol. 6, No. 5, May 1968,*
pp. 923–925)

The purpose of this report is to present heat-transfer measurements in the separation region associated with oblique shock compression up to the ambient exit pressure. Pressure measurements are also presented.

The air flow through the nozzle was heated to a stagnation temperature T_t of 1500° R, the cooled wall temperature T_w ranged from 550 to 700° R, and the ambient air temperature T_{amb} was approximately 530° R.

B02 EFFECTS OF SURFACE COOLING AND HEATING ON STRUCTURE OF LOW-SPEED, LAMINAR BOUNDARY-LAYER GAS FLOWS WITH CONSTANT FREE-STREAM VELOCITY

Back, L. H.
Technical Report 32-1301 (Unclassified)
(Reprint of Paper 68-HT-23, presented at the AIChE-ASME
Heat Transfer Conference and Exhibit, Philadelphia,
Pennsylvania, August 11–14, 1968)

Motivated by very large gas-to-wall temperature ratios found in devices such as arc heaters, analytical investigations were made of the effects of heating and of severe surface cooling on the structure of a laminar boundary layer. Quantities calculated include velocity, mass flux, and enthalpy distributions across the boundary layer; thicknesses associated with velocity and enthalpy layer; thicknesses related to boundary-layer displacement and momentum and energy defects; and heat transfer and shear-stress distributions along the surface. To obtain the quantities, laminary boundary-layer equations were solved, on a digital computer, for a large range of cooling conditions for low-speed, constant free-stream velocity flow of a perfect gas over a surface at a constant temperature. The free-stream-to-wall enthalpy ratio ranged from 1 to 100, with property variation exhibited by actual gases taken into account, while the heating-effect study covered wall-to-free-stream enthalpy ratios up to 10. Therefore, the calculations apply to a broad range of cooling and heating conditions, but not those conditions where dissociation, ionization, and radiation effects become important. The solution method and results are discussed, and existing prediction methods are appraised.

B03 CONSERVATION EQUATIONS OF A VISCOUS, HEAT-CONDUCTING FLUID IN CURVILINEAR ORTHOGONAL COORDINATES

Back, L. H.
Technical Report 32-1332, September 15, 1968
(Unclassified)

A complete written set of the conservation equations of a viscous, heat-conducting fluid is given in curvilinear orthogonal coordinates. Scale factors for a number of coordinate systems are tabulated for convenience in expressing the equations in various coordinates.

B04 LAMINAR HEAT TRANSFER IN ELECTRICALLY CONDUCTING FLUIDS FLOWING IN PARALLEL PLATE CHANNELS

Back, L. H.
Technical Report 32-1335 (Unclassified)
(Reprinted from *International Journal of Heat and
Mass Transfer, Vol. 11, No. 11, pp. 1621–1631,
November 1968)

Presented in this report are predicted wall heat fluxes, bulk fluid temperatures, and Nusselt numbers in the thermal entrance region for a steady, constant-property, uniform laminar flow of an electrically conducting fluid in a constant cross-section, parallel-plate channel with isothermal, electrically nonconducting walls. Uniform magnetic and electric fields are applied perpendicular to each other and to the flow. The predictions of temperature distribution (taking into account longitudinal heat conduction) depend upon location along the channel, the product of Reynolds and Prandtl numbers ($RePr$), and upon a Joule heating parameter S. Thermal entrance lengths, proportional to $RePr$, decrease with Joule heating, and are of the order of the channel height for small $RePr$. Existing predictions of velocity entrance lengths are included for comparative purposes and the fully-developed region is also discussed.

Bamford, R. M.

B05 APPLICATION OF STRUCTURAL ANALYSIS AND MATRIX INTERPRETIVE SYSTEM

Bamford, R. M.
Technical Memorandum 33-399, October 15, 1968
(Unclassified)

The matrix manipulations required for common structural analysis problems are developed, the control cards that direct the structural analysis and matrix interpretive system to perform these operations are listed, the required data are described, and a sample problem is given.

Bathker, D. A.

B06 RADIO-FREQUENCY PERFORMANCE OF AN 85-FT GROUND ANTENNA: X-BAND
Bathker, D. A.
Technical Report 32-1300, July 1, 1968
(Unclassified)

The NASA/JPL Deep Space Instrumentation Facility 85- and 210-ft paraboloidal ground antennas have previously been demonstrated to operate well below gain limit at S-band. The results of approximately 6 weeks of experimental effort together with supporting studies of an 85-ft paraboloid at X-band are given. Determinations of the aperture efficiency by independent methods are in close agreement and show the system remains below gain limit at X-band. Mechanical perturbations, including ordered changes in the paraboloid focal length, were evaluated by radio-frequency, and machine-reduced field data were obtained by civil engineering techniques.

B07 THE ULTRA CONE: AN ULTRA-LOW-NOISE SPACE COMMUNICATION GROUND RADIO-FREQUENCY SYSTEM
Levy, G. S., Bathker, D. A., Higa, W., Stelzried, C. T.
Technical Report 32-1340 (Unclassified)
(Reprinted from *IEEE Transactions on Microwave Theory and Techniques*, Vol. MTT-16, No. 9, pp. 596–602, September 1968)

For abstract, see Levy, G. S.

Bejczy, A. K.

B08 FUEL-OPTIMAL RETROTHRUST CONTROL PROBLEMS FOR PROPULSIVE SOFT-LANDING MANEUVERS IN THE PRESENCE OF DRAG
Bejczy, A. K.
Technical Report 32-1361, June 1, 1969
(Unclassified)

A fuel-optimal retrothrust control program is demonstrated to be highly superior to an acceleration-type control law for the terminal phase of a propulsive soft-landing mission to an atmospheric planet, using either a vertical trajectory or a gravity-turn ballistic trajectory. These trajectories are considered under conditions in which (1) the drag depends quadratically on the velocity and inverse-exponentially on the altitude, (2) it is desirable to reach zero velocity at zero altitude, and (3) the terminal value of the ballistic path angle is unspecified. The equivalent terminal-value optimal control

problem (maximizing the final mass of the space vehicle), which could be termed an "inverse" Goddard Problem, is treated by applying Pontryagin's Maximum Principle. It is proved that for both types of trajectories, the fuel-optimal retrothrust control program is always of the bang-bang type, composed of only two sections in the optimal control sequence. The fuel-optimal retrothrust control, when compared with the results of the acceleration-type control law, gives a decrease of 35 and 55% in fuel consumption for the vertical and ballistic trajectories, respectively, and a decrease of 45 and 75% in required controlled landing time for the two types of trajectories, respectively.

Benedict, A. G.

B09 RELIABILITY-CONFIDENCE COMBINATIONS FOR SMALL-SAMPLE TESTS OF AEROSPACE ORDNANCE ITEMS
Benedict, A. G.
Technical Report 32-1165, July 1, 1968 (Revision 1)
(Unclassified)

Reliability-confidence combinations for small-sample, no-fail tests of aerospace ordnance items are considered in some detail. Analyses epitomized by the widely used, but sometimes misapplied, equation

$$\gamma = 1 - R^n$$

are shown to provide unexpectedly good approximations. Component reliabilities corresponding to confidences of the order of 70%, as based on tests by attributes, are shown to be satisfactory for calculation of simple series and parallel system reliabilities; it is suggested that 70% confidence levels may also be a good choice for tests by variables.

Benes, M.

B10 RELATIVE AND ABSOLUTE ORIENTATION ERROR ANALYSIS
Benes, M.
Technical Report 32-1344 (Unclassified)
(Reprinted from *Photogrammetric Engineering*, Vol. 34, pp. 1186–1197, November 1968)

Because of peculiarities of extraterrestrial photography (TV transmission, low resolution, small vidicon format, small base-to-height ratio, etc.), relative orientation of a photogrammetric stereopair either cannot be reconstructed at all, or resulting residual and standard errors are excessively large. Therefore, instead of using observed image coordinates, exterior orientation data are used for a "forced" relative orientation. This way model coordinates can always be computed; however, the question of their accuracy is a critical one. Based on the principle of collinearity, the law of propagation of errors is applied to the basic analytical relative orientation relation, and a complete error analysis considering the influence of all involved parameters is derived. Absolute orientation represents then a similar problem, because in extraterrestrial cases

ground control points usually are not available and therefore exterior orientation data must also be used. Again, a similar error analysis is determined. The relations were programmed for an IBM computer and, using different combinations of parameters, statistical data were obtained.

Berman, A. L.

B11 ABTRAJ–ON-SITE TRACKING PREDICTION PROGRAM FOR PLANETARY SPACECRAFT
Berman, A. L.
Technical Memorandum 33-391, August 15, 1968
(Unclassified)

The On-Site Tracking Program for planetary spacecraft provides the capability to generate predictions at the local tracking stations during emergency or unscheduled passes and to more efficiently use JPL resources. This Fortran program for the SDS 920/930 series computers with one magnetic tape unit and input/output typewriter uses one main prediction routine ABTRAJ and subroutines for trajectory, sun and moon ephemeris data, date, and time functions. The accuracy comparison of the program with the JPL Trajectory Program indicates that errors fall well within any operational tolerances.

Berman, P.

B12 EFFECTS OF ENVIRONMENTAL EXPOSURES ON SILICON SOLAR CELLS
Moss, R., Berman, P.
Technical Report 32-1362, January 15, 1969
(Unclassified)

For abstract, see Moss, R.

Bird, T. H.

B13 SURVEYOR V MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1246, July 15, 1968
(Unclassified)

This three-part document constitutes the Project Mission Report on Surveyor V, the fifth in a series of unmanned lunar soft-landing missions. Part III consists of 164 selected pictures from Surveyor V and appropriate explanatory material; 39 mosaics composed of individual frames are also included.

B14 SURVEYOR VI MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1262, August 15, 1968
(Unclassified)

This three-part document constitutes the Project Mission Report on Surveyor VI, the sixth in a series of unmanned lunar soft-landing missions. Part III presents 139 of the Sur-

veyor VI television pictures transmitted to earth from the lunar surface, between November 10 and November 24, 1967; 46 mosaics composed of individual frames are also included. Appropriate information for interpreting these pictures is given in the individual sections of the report.

B15 SURVEYOR VII MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1264, September 1, 1968
(Unclassified)

This three-part document constitutes the Project Mission Report on Surveyor VII, the last spacecraft in a series of unmanned lunar soft-landing missions. Part III consists of selected pictures from Surveyor VII and appropriate explanatory material. Most of the results given in this report are based on data evaluation prior to March 15, 1968. It is expected that future evaluation and analysis of the Surveyor VII data will provide additional science results.

Blair, M. F.

B16 PERFORMANCE OF THE JPL 43-in. HYPERSONIC SHOCK TUNNEL
Blair, M. F.
Technical Report 32-1370, March 15, 1969
(Unclassified)

Shock speeds and test times have been calculated and measured for the 3-in.-diameter shock tube which supplies the hot gas for the JPL 43-in.-diameter hypersonic shock tunnel. The pressures recorded at, and near the end of the driven tube, both with a closed end and with the shock tunnel attached, have been explained and time-resolved. Tailoring, or equilibrium interface operation, was observed for $5.7 \gtrsim M_s \gtrsim 5.4$ for cold H_2 driving N_2. Tailoring Mach number limitation is correlated with the results for mixing due to bifurcation effects. Starting wave speeds were measured and calculated for the hypersonic nozzle, and a pitot survey was made of the working region. The testing region had a Mach number of approximately 12.5 when the 1-in.-diameter throat was used for the nozzle. Attempts to employ flow visualization techniques were unsuccessful.

Blinn, J. C., III

B17 AIRBORNE MULTIFREQUENCY MICROWAVE RADIOMETRIC SENSING OF AN EXPOSED VOLCANIC PROVINCE
Blinn, J. C., III (Jet Propulsion Laboratory)
Chapman P., Quade, J. (University of Nevada)
Technical Memorandum 33-405, October 15, 1968
(Unclassified)

In support of the NASA Earth Resources Program, an empirical study was conducted, using airborne and ground based

sensors, to search for correlations between multispectral microwave brightness temperatures and geologic parameters. The test site, in the vicinity of Mt. Lassen, Calif., was chosen because of its simple topography, large distinct areas of homogeneous composition, roughness characteristics, and lack of vegetation. Radiometers, operating at 9.3, 15.8, 22.2, and 34.0 GHz, were flown over preselected flight lines four times per flight to collect data.

Results of the ground truth studies and analysis of the aircraft overflights show a distinction between cinder and lava, two chemically similar materials with different surface characteristics. Results from an area of cinder layered over lava show a distinctive response, which may be related to cinder thickness. An improved experiment, which uses more temperature probes, geologic cross sections, a ground-based microwave radiometer, and other refinements, is recommended.

Bollman, W. E.

B18 AN AMBIGUITY IN THE ORBIT DETERMINATION OF PLANETARY FLYBY TRAJECTORIES
Bollman, W. E.
Technical Report 32-1331, November 1, 1968
(Unclassified)

As new space missions from earth to the planets are designed, more accurate estimating of the in-flight trajectory will be required to complement the more complex scientific experiments. Conventional methods of in-flight orbit determination, such as two-way-doppler and range measurements from one or more ground tracking stations, have demonstrated the high accuracy that can be achieved. Traditionally the accuracy of orbit estimation becomes very good near the planet when the spacecraft speeds up under the planet's gravitational attraction and thus as the doppler changes are magnified. The purpose of this study is to analyze the geometrical properties of spacecraft doppler measurements made near a planet and to show that under certain situations an orbit-determination program could converge to an incorrect solution for the planet-centered inclination of the spacecraft hyperbolic orbital plane. Methods of correcting the situation are also presented.

Bonnell, J. M.

B19 AN INVESTIGATION OF SPHERICAL BLAST WAVES AND DETONATION WAVES IN A ROCKET COMBUSTION CHAMBER
Bonnell, J. M.
Technical Report 32-1286, August 15, 1968 (Unclassified)

An investigation was conducted to determine the nature of the shock-like wave produced by an explosion in a liquid propellant rocket combustion chamber. A relatively simple model of the wave behavior was devised. It consisted of a spherical blast wave that developed into a steadily propagating Chapman–Jouguet plane detonation wave. The behavior of the blast wave close to the explosive source was determined by a series of bomb tests conducted in a chamber pressurized with nitrogen. The behavior of a spherical wave in a reacting medium was determined by exploding bombs mounted on the axial centerline of a rocket combustor in a series of rocket motor firings. A comparison of the theoretical and actual times for a wave to travel from its source to the chamber wall indicated that the actual times were appreciably larger. However, the theoretical detonation conditions of the combustion chamber were rather ill-defined and could be adjusted to accommodate the experimental results. The results indicated that the bomb-generated wave, on its first pass to the wall, behaved more like a blast wave than a detonation wave.

Borncamp, F.

B20 THE RANGER IX FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.
Technical Report 32-767, November 1, 1968
(Unclassified)

For abstract, see Vegos, C. J.

Boundy, R. A.

B21 A LIGHTWEIGHT 6½-ft AEROSHELL FOR AN EARLY MARS PROBE MISSION
Nagler, R. G., Boundy, R. A. (Jet Propulsion Laboratory)
Scholl, J. R., Dawson, J. B. (Rohr Corporation)
Technical Report 32-1325, September 15, 1968
(Unclassified)

For abstract, see Nagler, R. G.

Bunce, R. C.

B22 UNIFIED S-BAND RECEIVER–EXCITER SUBSYSTEM
Bunce, R. C.
Technical Report 32-809, September 15, 1968
(Unclassified)

This report summarizes the functional capabilities and physical arrangement of the receiver–exciter subsystem that is a part of the unified S-band Apollo communications and tracking ground-station system. The report is based on a talk given at the Apollo Unified S-Band Technical Conference held at Goddard Space Flight Center, Greenbelt, Maryland, on July 14 and 15, 1965.

The functional operation is initially described in relation to the other interfacing equipment by separate explanations of four relatively independent capabilities: doppler extraction,

two-way communications, angle-tracking, and ranging. Somewhat more detailed information is then presented for the main receiver phase-lock and automatic gain control loops, and the ranging receiver phase-lock loops.

Butman, S.

B23 SYNCHRONIZATION OF PCM CHANNELS BY THE METHOD OF WORD STUFFING
Butman, S.
Technical Report 32-1279 (Unclassified)
(Reprinted from *IEEE Transactions On Communication Technology, Vol. Com-16, No. 2, April 1968, pp. 252–254*)

The pulse stuffing technique for rate equalization of digital channels is extended in this report to the stuffing of a sequence of pulses (a word), which can be coded. The extra capacity needed for signaling the stuffed word decreases exponentially with the number of pulses in it, and may be eliminated at a negligible increase in the error rate of the channel.

Cameron, R. E.

C01 ABUNDANCE OF MICROFLORA IN SOILS OF DESERT REGIONS
Cameron, R. E.
Technical Report 32-1378, May 15, 1969
(Unclassified)

Surface soils were collected by aseptic techniques from widely varying desert areas, and were analyzed for physical, chemical, and microbiological properties. The soils showed a wide range of properties but were generally greyish, yellowish, or brownish sands, low in organic matter and cation exchange capacity. There were detectable concentrations of water-soluble ions, and pH values above 7.0, except in volcanic areas. Total microbial abundances ranged from zero (undetectable) to $> 10^8/g$ of soil. Aerobic and microaerophilic bacteria were most abundant, followed by algae and molds. The anaerobic bacteria were generally least abundant or undetectable. Predominant microflora included *Bacillus* species, soil diphtheroids, *Schizothrix* species and other oscillatorioid blue-green algae, *Streptomyces* species, *Penicillium* species, and *Aspergillus* species.

Campbell, B. A.

C02 STUDIES ON ETHYLENE OXIDE–FREON 12 DECONTAMINATION AND DRY-HEAT STERILIZATION CYCLES
Kalfayan, S. H., Silver, R. H., Campbell, B. A.
Technical Report 32-1310, August 15, 1968
(Unclassified)

For abstract, see Kalfayan, S. H.

Cary, C. N.

C03 GRAVITATIONAL INCONSISTENCY IN THE LUNAR THEORY: CONFIRMATION BY RADIO TRACKING
Cary, C. N., Sjogren, W. L.
Technical Report 32-1290, Part II (Unclassified)
(Reprinted from *Science, Vol. 160, May 24, 1968, pp. 875–876*)

When range and doppler observations of space probes near or on moon are reduced by use of a lunar ephemeris calculated from the Brown lunar theory, residuals as large as 440 m in position and 1.5 mm/s in velocity are observed. When the calculations are repeated with use of the integrated lunar ephemeris described, the residuals are greatly reduced.

Case, R. K.

C04 ELECTROMAGNETIC INTERFERENCE ASPECTS OF INTEGRATING A UHF/VHF RECEIVER ONBOARD MARINER V
Case, R. K., Keeler, L. H.
Technical Report 32-1315, November 1, 1968
(Unclassified)

On a spacecraft, electronic equipment in close proximity must operate in the environment of noise generated by every other device on that spacecraft. When the electronic equipment is a sensitive radio receiver, the spacecraft noise can affect the sensitivity of the receiver if the noise is in its passband. The tasks involved in the integration of a dual-frequency receiver (DFR) on *Mariner V* as part of the complement of scientific instruments are discussed in this report. The primary effort was that of ensuring proper experiment operation after it was determined that noise contributed by the spacecraft was excessive at 49.8 MHz and that there was an interaction of the DFR 423.3-MHz channel with the S-band telecommunications ranging system. The criteria for verifying proper system operation and the modifications necessary for establishing a compatible spacecraft environment are discussed.

Chahine, M. T.

C05 INVERSE PROBLEMS IN RADIATIVE TRANSFER. PART I: DETERMINATION OF THE TEMPERATURE PROFILE IN AN ATMOSPHERE FROM ITS OUTGOING RADIANCE
Chahine, M. T.
Technical Report 32-1351, Part I (Unclassified)
(Reprinted from *Journal of the Optical Society of America, Vol. 58, No. 12, pp. 1634–1637, December 1968*)

A highly convergent relaxation method has been developed for the inversion of the full radiative-transfer equation. The results of the iterative solution indicate that convergence can be achieved over a wide range of initial estimates, enabling the temperature profile of a relatively unknown atmosphere to be unambiguously determined. The method is illustrated by examples for the outgoing radiance in the earth's atmosphere in the region of the 4.3-μ CO_2 band, but can be similarly applied in other frequency ranges.

Chapman, C. P.

C06 SCANNING TECHNIQUES FOR RANDOM NOISE TESTING
Chapman, C. P.
Technical Report 32-1259 (Unclassified)
(Reprinted from *The Journal of Environmental Sciences,*
Vol. 11, No. 1, pp. 27–35, February 1968)

When conducting random noise vibration tests it is necessary to equalize the structure gains of the system (shaker, test fixture, and specimen). Automatic spectrum equalizer/analyzer systems have been developed to control random noise tests; however, these commercially manufactured instruments can utilize only a single-signal source (the output of a single accelerometer). If additional accelerometers are to be employed for control of the vibration levels to the test specimen, it is necessary to provide some means of sampling each of the accelerometer signals. The sampling must be conducted in such a manner that all the frequency information necessary for the automatic equalization equipment is preserved and no additional frequencies are introduced by the scanning or sampling technique. The multiple channel accelerometer scanners developed at JPL's Environmental and Dynamic Testing Laboratory meet this requirement.

Chapman, P.

C07 AIRBORNE MULTIFREQUENCY MICROWAVE RADIOMETRIC SENSING OF AN EXPOSED VOLCANIC PROVINCE
Blinn, J. C., III (Jet Propulsion Laboratory)
Chapman, P., Quade, J. (University of Nevada)
Technical Memorandum 33-405, October 15, 1968
(Unclassified)

For abstract, see Blinn, J. C., III

Clayton, R. M.

C08 THE INFLUENCE OF SEVERAL NEAR-WALL INJECTION CONDITIONS ON THE COMBUSTION PERFORMANCE OF A LIQUID ROCKET ENGINE
Clayton, R. M.
Technical Report 32-1283, September 15, 1968
(Unclassified)

Efforts to achieve smooth combustion and to establish steady-state behavior of a combustor under a variety of injected flow conditions have been summarized. The experimental combustion performance of an 18-in.-diam engine was found to vary under different near-wall injection conditions. Because of combustion effects, considerable spray separation is present in a main (core) flow. This separation degrades propellant mixing, especially along the outer periphery of the main flow, and produces as much as 10% performance variation, depending on the particular operating conditions of an ancillary injection scheme located near the chamber wall. A maximum performance recovery was achieved near the optimum mixture ratio for spray mixing for the boundary injector elements.

A rough combustion mode, manifested by high-amplitude disturbances of combustion pressure, was aggravated by poor stability of the streams from the boundary injection system. This condition was alleviated (but not eliminated) by modifications to the hydraulic design of the boundary system.

C09 AN EXPERIMENTAL DESCRIPTION OF DESTRUCTIVE LIQUID ROCKET RESONANT COMBUSTION
Clayton, R. M., Rogero, R. S., Sotter, J. G.
Technical Report 32-1293 (Unclassified)
(Reprinted from *AIAA, Vol. 6, No. 7,* July 1968,
pp. 1252–1259)

A steep-fronted, high-amplitude pressure wave sweeping about the combustion chamber axis during a destructive liquid-rocket resonant-combustion mode leads to the consideration of a rotating detonationlike wave concept to explain the phenomenon. Results of a portion of the experimental phase of the investigation show some of the spatial properties of the wave for a variety of chamber geometries. Nitric acid and aniline/furfuryl alcohol propellants are used at a nominal thrust of 20,000 lbf and a chamber pressure of 300 psia. The wave geometry is deduced from multiple high-response measurements. The pressure-wave-to-chamber-wall intersection is found to curve in the direction of wave rotation with the nozzle end of the intersection substantially leading the injector end. The wave-to-injector-face intersection extends into the central area of the face, although the wave becomes weak in this area. The observed pressure ratio across the wave front varies from in excess of 20:1 near the injector to 4:1 near the nozzle entrance. The nonsymmetrical wave exhibits a shocklike transient at certain chamber locations.

Conel, J. E.

C10 LUNAR EXPLORATION: THE IMPACT OF *RANGER* AND *SURVEYOR* RESULTS
Stewart, H. J., Hibbs, A. R., Conel, J. E., Rindfleisch, T.
Technical Report 32-1399 (Unclassified)
(Reprinted from *Astronautics and Aeronautics,* Vol. 7,
No. 1, January 1969)

For abstract, see Stewart, H. J.

Craven, C. W.

C11 PLANETARY QUARANTINE AND SPACE VEHICLE STERILIZATION
Craven, C. W., Stern, J. A., Ervin, G. F.
Technical Report 32-1276 (Unclassified)
(Reprinted from *Astronautics & Aeronautics,*
Vol. 6, No. 8, pp. 18–48, August 1968)

At the COSPAR meeting in Florence, Italy, in May 1964, a study group in standards for space-vehicle sterilization met at the behest of the organization's Consultative Group on Potentially Harmful Effects of Space Experiments. The study group, which included members from Sweden, the U.S., France,

Belgium, the USSR, and the U.K., concluded that the probability of a single viable organism being aboard any vehicle intended for a Mars landing should be less than 10^{-4}. (Subsequent COSPAR deliberations have recommended that this figure be increased to 10^{-3}.)

The sterilization effort described here permits unmanned exploration of Mars and Venus to go forward with confidence that terrestrial microbial contamination can be controlled adequately and the planetary-quarantine constraints met.

C12 A PRELIMINARY QUARANTINE ANALYSIS OF A POSSIBLE *MARINER* VENUS 1972 MISSION

Craven, C. W., Sherry, E. J., Stern, J. A.
Technical Memorandum 33-377, April 15, 1968
(Unclassified)

A preliminary quarantine analysis of a possible *Mariner* Venus 1972 mission has been carried out to identify technical areas requiring further investigations or actions. Quarantine constraints for the analysis were derived from prior constraints established for earlier planetary missions. A quarantine allocation model was developed that permits easy test of the probability of contamination from key sources. Concern was mainly directed to the lander capsule, spacecraft, biobarrier, and various debris as possible sources of contamination. Various mission modes considered included separation or no separation of the planetary vehicle, separation and bias aiming of the spacecraft to avoid impact, and separation but crashing spacecraft.

Cuffel, R. F.

C13 HEAT-TRANSFER MEASUREMENTS IN THE SHOCK-INDUCED FLOW SEPARATION REGION IN A SUPERSONIC NOZZLE

Back, L. H., Massier, P. F., Cuffel, R. F.
Technical Report 32-1278 (Unclassified)
(Reprinted from *AIAA Journal*, Vol 6, No. 5, May 1968, pp. 923–925)

For abstract, see Back, L. H.

Davis, J. P.

D01 A CONTROL SYSTEM STUDY FOR AN IN-CORE THERMIONIC REACTOR

Weaver, L. E., Gronroos, H. G., Guppy, J. G., Davis, J. P.
Technical Report 32-1355, January 15, 1969
(Unclassified)

For abstract, see Weaver, L. E.

Dawson, J. B.

D02 A LIGHTWEIGHT 6½-ft AEROSHELL FOR AN EARLY MARS PROBE MISSION

Nagler, R. G., Boundy, R. A. (Jet Propulsion Laboratory)
Scholl, J. R., Dawson, J. B. (Rohr Corporation)

Technical Report 32-1325, September 15, 1968
(Unclassified)

For abstract, see Nagler, R. G.

Devine, C. J.

D03 GRAVITATIONAL INCONSISTENCY IN THE LUNAR THEORY: NUMERICAL DETERMINATION

Mulholland, J. D., Devine, C. J.
Technical Report 32-1290, Part I (Unclassified)
(Reprinted from *Science*, Vol. 160, May 24, 1968, pp. 874–875)

For abstract, see Mulholland, J. D.

Dickinson, R. M.

D04 LARGE SPACECRAFT ANTENNA STUDY ANALYTICAL PATTERN SUBTASK

Dickinson, R. M.
Technical Report 32-1352, January 15, 1969
(Unclassified)

This report presents the results of an analytic and experimental program to develop techniques for calculating the circularly polarized patterns of erectable spacecraft high-gain antennas. Surface equations for one class of radial rib erectable antenna are derived. Mathematical expressions are developed for calculating the far field circularly polarized patterns based upon the reflector surface equations and circularly polarized feed illumination patterns.

Experimental measured patterns were obtained to compare with the computer calculated theoretical patterns. Sample computer programs used to obtain the best focus position and to calculate patterns are contained in the Appendix.

D05 COST EFFECTIVENESS OF SPACECRAFT POINTING ANTENNAS

Dickinson, R. M.
Technical Memorandum 33-390, June 15, 1968
(Unclassified)

This memorandum presents an analysis of the minimum telecommunication cost for data return at planetary distances using pointing antennas. The system analyzed concerns only the related communications downlink portions of a spacecraft and the Deep Space Network ground stations and Space Flight Operations Facility. A solar-cell-powered spacecraft using either a programmed pointing or RF tracking antenna is assumed. Based upon the assumptions made, spacecraft RF tracking antennas are shown to be more cost effective than programmed pointing antennas for the return of greater than 10^{10} bits of data from Mars or greater than 10^8 bits from Jupiter. The results of the analysis are sensitive to certain cost and performance assumptions, which are discussed in the memorandum.

Didday, R. L.

D06 SUBCARRIER TRACKING METHODS AND COMMUNICATION SYSTEM DESIGN
Didday, R. L., Lindsey, W. C.
Technical Report 32-1317 (Unclassified)
(Reprinted from *IEEE Transactions on Communication Technology*, Vol. COM.-16, No. 4, pp. 541-550, August 1968)

It is advantageous from power considerations to allow suppressed-carrier coherently-detected communications. Two methods for generating a coherent reference for the demodulation of a suppressed-carrier signal, namely, the squaring loop and the mathematically equivalent Costas loop, are analyzed, including at some points the effects of voltage-controlled oscillator noise and initial frequency detuning. The steady-state phase error probability distribution is presented, as is the expected time to first loss of lock in the first-order loop. Probabilities of error in coded or uncoded telemetry systems which use a squaring loop to generate a coherent subcarrier reference are investigated, allowing appropriate values of system parameters to be chosen by system designers.

Divita, E. L.

D07 SOLAR PROTON FORECAST SYSTEM AND PROCEDURES USED DURING THE MARINER V MISSION
Gonzalez, C. C., Divita, E. L.
Technical Report 32-1303, October 1, 1968
(Unclassified)

For abstract, see Gonzalez, C. C.

Dobbins, R. A.

D08 A COMPARISON OF TWO METHODS OF MEASURING PARTICLE SIZE OF Al₂O₃ PRODUCED BY A SMALL ROCKET MOTOR
Dobbins, R. A. (Brown University)
Strand, L. D. (Jet Propulsion Laboratory)
Technical Report 32-1383, June 1, 1969
(Unclassified)

The size of the particulate effluent of rocket motors containing aluminum as a fuel additive must be known in order to predict the thrust loss due to particle lag, the particulate radiant heat transfer, the particulate acoustic attenuation, particle impingement, and the plume structure and properties. The particle size of the Al_2O_3 produced by a small rocket motor was determined by tank collection and by spectrophotometric tests to explain a previous discrepancy and to learn to use these test methods in a mutually complementary fashion. Tank collection tests were performed with tank volume, aluminum loading in the propellant, and chamber pressure as the principal variables. The particle size data from tank collection tests was analyzed in the form of various mean diameters, moment ratios, and the mass median diameter. Spectrophotometric tests were performed at three wave-

lengths on motors with chamber pressure and aluminum content as principal variables. The tank collection tests gave internally consistent results only when the mean size was defined in terms of the low moments of the distribution function. These mean diameters show the same mild growth with chamber pressure as indicated by the optical measurements.

Dumas, L. N.

D09 TEMPERATURE CONTROL OF THE MARINER VENUS 67 SPACECRAFT
Dumas, L. N.
Technical Report 32-1284, July 15, 1968
(Unclassified)

The variation in solar intensity during the *Mariner V* mission made effective solar isolation a requirement for spacecraft survival. The temperature control design is presented, with emphasis on the design features that provided this isolation. The results of thermal testing and flight temperature data are summarized and discussed.

Duxbury, T. C.

D10 NEAR-ENCOUNTER GEOMETRY GENERATION
Duxbury, T. C.
Technical Report 32-1338, November 15, 1968
(Unclassified)

A method is presented for generating the near-encounter spacecraft–target-planet celestial geometry by including the motion of the spacecraft–target-planet system about the sun in the two-body trajectory solution. This method has been incorporated in a computer program that has been used to simulate an earth–Mars trajectory. The computer program, which uses output data from the SPACE–Single Precision Cowell Trajectory Program as input, is presented along with the results from the trajectory studied.

Dyckman, L.

D11 THE 10-FT SPACE SIMULATOR AT THE JET PROPULSION LABORATORY
Alexander, W., Dyckman, L., Harrell, J., Nelson, W., Schaefle, W.
Technical Report 32-1231, Revision 1, January 15, 1969
(Unclassified)

For abstract, see Alexander, W.

Earnest, J. E., Jr.

E01 FIRING SQUIBS BY LOW-VOLTAGE CAPACITOR DISCHARGE FOR SPACECRAFT APPLICATION
Earnest, J. E., Jr., Murphy A. J.
Technical Report 32-1230, October 15, 1968
(Unclassified)

The design of low-voltage capacitor-discharge circuits for firing hot bridgewire squibs requires that squib *thermal* and circuit *electrical* time-constants be considered as interrelated.

These functional relationships are analyzed by use of an electro-thermal analogy with one composite time-constant. The effects of secondary characteristics not considered in the simple analogy are also discussed.

Easterling, M. F.

E02   A HIGH-RATE TELEMETRY SYSTEM FOR THE MARINER MARS 1969 MISSION
Tausworthe, R. C., Easterling, M. F., Spear, A. J.
Technical Report 32-1354, April 1, 1969
(Unclassified)

For abstract, see Tausworthe, R. C.

Ebersole, M. M.

E03   A COMPUTER PROGRAM FOR SIMPLIFYING IN-COMPLETELY SPECIFIED SEQUENTIAL MACHINES USING THE PAULL AND UNGER TECHNIQUE
Ebersole, M. M., Lecoq, P. E.
Technical Report 32-997, November 15, 1968
(Unclassified)

This report presents a description of a computer program mechanized to perform the Paull and Unger process of simplifying incompletely specified sequential machines. (An understanding of the process is a prerequisite to the use of the techniques presented in this report.) This process has specific application in the design of asynchronous digital machines and was used in the design of operational support equipment for a *Mariner*-type spacecraft central computer and sequencer. A typical sequential machine design problem is presented to show where the Paull and Unger process has application. A description of the Paull and Unger process together with a description of the computer algorithms used to develop the program mechanization are presented. Several examples are used to clarify the Paull and Unger process and the computer algorithms. Program flow diagrams, program listings, and a program-user operating procedure are included as appendixes.

Eddy, R. P.

E04   DESIGN AND CONSTRUCTION OF THE 15-ft-BEAM SOLAR SIMULATOR SSI5B
Eddy, R. P.
Technical Report 32-1274, October 1, 1968
(Unclassified)

The modification of the JPL 25-ft space simulator to incorporate a larger, higher quality solar simulator produced an initial 15-ft-diam beam of better than ±5% uniformity measured throughout the test volume. Although similar in general arrangement to the SS6A system developed for the 10-ft simulator, it employs several new developments. The uniformity and collimation are improved by defocusing and rotating the collimator and by using the aberration effect of

the condensing lenses in the mixer lens assembly. The efficiency has been improved by incorporating a lens in the vacuum interface window. The use of water-cooled, 20-kW xenon arc lamps allows the system to be operated with a fewer number of lamps and related support equipment. The conservative design of the SS15B simulator makes available sufficient reserve power which can be used for enlarging the beam to the ultimate 20-ft diam, providing up to planet Mercury radiance, reducing the collimation angle, or improving the spectrum by selective filtering.

Elliott, D. G.

E05   VARIABLE-VELOCITY MHD INDUCTION GENERATOR WITH ROTATING-MACHINE INTERNAL ELECTRICAL EFFICIENCY
Elliott, D. G.
Technical Report 32-1328 (Unclassified)
(Reprinted from *AIAA Journal, Vol. 6, No. 9,* pp. 1695–1702, September 1968)

A traveling-wave, MHD induction generator with varying fluid velocity between inlet and exit can have the same internal electrical efficiency as a rotating induction generator. The fraction of electric retarding work converted to electric output at each station in the flow channel is $(1 + s)^{-1}$ where s is the local slip $(U - U_s)/U_s$ between the velocity of the fluid U and the velocity of the zero-crossing of the magnetic field wave U_s. To produce the rotating-machine efficiency, the product of magnetic field amplitude, wave velocity, and flow channel width is held constant from inlet to exit. The local slip can be freely chosen for maximum electric output from the fluid in the presence of friction, and the inlet magnetic field can be selected for maximum output after winding and end losses. An efficiency of 0.63 is found possible with a 325-kw lithium generator.

Ervin, G. F.

E06   PLANETARY QUARANTINE AND SPACE VEHICLE STERILIZATION
Craven, C. W., Stern, J. A., Ervin, G. F.
Technical Report 32-1276 (Unclassified)
(Reprinted from *Astronautics & Aeronautics, Vol. 6, No. 8,* pp. 18–48, August 1968)

For abstract, see Craven, C. W.

Ferrera, J. D.

F01   A METHOD FOR CALCULATING STEADY-STATE THRUST AND FLOW-RATE LEVELS FOR MARINER IV TYPE ATTITUDE CONTROL NITROGEN GAS JETS
Ferrera, J. D., McKown, P. M.
Technical Report 32-1353, December 1, 1968
(Unclassified)

The work presented in this report is limited to steady-state thrust and flow-rate determinations versus varying design parameters for the *Mariner IV* type ball-valve/nozzle configurations, where a subsonic orifice is in series with a sonic nozzle throat separated by a chamber volume of approximately 0.2 cm³. Design variables investigated included inlet pressure of 10 to 35 psi, ambient pressure of 1×10^{-6} torr, inlet temperature of -100 to $+150°C$, valve orifice area of 5×10^{-4} to 40×10^{-4} in.², nozzle throat diameter of 5×10^{-3} to 50×10^{-3} in., nozzle geometric area ratio of 25:275, and nozzle cone half-angle of 15 to 40 deg.

Thrust levels considered are in the millipound range using cold nitrogen gas as the propellant. The equations used to determine nozzle losses are based on flat-plate analogies. The mathematical formulation and IBM 1620 computer program used in this analysis are also described.

Fischbach, D. B.

F02 THE EFFECT OF SUBSTRATE STRUCTURE ON THE DEPOSITION OF EVAPORATED CARBON
Fischbach, D. B.
Technical Report 32-1309, October 15, 1968
(Unclassified)

A carbon deposition effect similar to that reported by Lewis and Floyd, but one that requires a different explanation, was discovered during studies of tensile creep on pyrolytic and glassy carbons.

F03 BASAL-PLANE METALLOGRAPHY OF DEFORMED PYROLYTIC CARBON
Fischbach, D. B., Adkins, J. M.
Technical Report 32-1389, June 1, 1969
(Unclassified)

Normal metallographic polishing techniques work well on pyrolytic-carbon layer-edge surfaces, but can give misleading results when applied to the basal-plane surfaces of well annealed or deformed samples. The correct structure is obtainable, but it appears only briefly in a sequence of cyclically recurring disturbed structures generated by the loosening, break-up, and removal of thin surface layers as a function of polishing time. Basal-plane surface preparation by cleavage, a simpler and quicker method, avoids the ambiguities that can occur with polishing.

Frewing, H. K.

F04 MULTIPATH, POLARIZATION, AND POINTING LOSSES FROM A MARS LANDER
Frewing, H. K.
Technical Report 32-1333, December 15, 1968
(Unclassified)

A model and a computer simulation program have been developed for statistically estimating the multipath, polari-zation, and pointing losses associated with the communication link from a planetary lander. The model allows these losses to be estimated for a lander of any configuration, with any antenna array, with any antenna characteristics and impacting at any position on any planet. It accounts for the random distribution of surface slopes likely to be encountered by a planetary lander. It assumes specular reflection of circular polarized waves as the multipath interference mechanism.

Equations for computing multipath, polarization, and pointing losses are derived, as are the coordinate transformations required for converting the random impact conditions of a planetary lander into quantities required for the electro-magnetic equations. One hundred computer-simulated landings of a JPL Mars rough lander are carried out for one landing in which the earth is 45 deg above the western horizon and for another landing in which the earth is overhead. Statistical distributions of combined multipath, polarization, and pointing losses are computed for each of these landing conditions.

Appendixes justify the use of the planet surface model assumed, provide estimates of the surface slope distribution of the planet and of the antenna characteristics of the lander, compute combined losses as a function of planet rotation, and include a copy of the computer listing for the particular example given.

Garba, J. A.

G01 A PARAMETRIC STUDY OF VARIATIONS IN WEIGHT AND PERFORMANCE CHARACTERISTICS OF LARGE-AREA SOLAR ARRAYS
Oliver, R. E., Garba, J. A., Hix, J. H.
Technical Report 32-1337, March 1, 1969
(Unclassified)

For abstract, see Oliver, R. E.

Gavin, T. R.

G02 QUALITY ASSURANCE MONITORING OF THE MICROBIOLOGICAL ASPECTS OF THE STERILIZATION ASSEMBLY DEVELOPMENT LABORATORY
Gavin, T. R., Redmann, G. H., Taylor, D. M.
Technical Report 32-1398, May 1, 1969
(Unclassified)

The Jet Propulsion Laboratory Sterilization Assembly Development Laboratory (SADL) program was initiated to develop and optimize the techniques, facilities, and procedures necessary for the assembly, test, microbiological monitoring, and sterilization of a capsule system which would satisfy NASA planetary quarantine constraints with minimum effect on capsule reliability.

An important aspect of SADL was the development of the Quality Assurance (QA) functions and procedures associated with the required activities for the microbiological monitoring of the capsule system, including sterility verification of

material, the assay technique, certification of the facility, and the monitoring of personnel activity in the facility.

The SADL QA program demonstrated that QA personnel can play an effective role in monitoring microbiological operations by applying the same QA rationale used in their role in a hardware program. In particular, the application of QA methods identified the need for improvement in assay methodology and techniques (as evidenced by a 0 to 30% variation in contamination of sterile samples over 16 repetitive assemblies). In addition, the QA inspection reports identified the procedural violations occurring during assembly which, when reviewed, resulted in the identification of the probable cause of 75% of the bio-burden buildup on the capsule.

Gayman, W. H.

G03 MEASUREMENT OF STRUCTURAL TRANSFER FUNCTIONS SIGNIFICANT TO FLIGHT STABILITY OF THE SURVEYOR SPACECRAFT

Gayman, W. H., Trubert, M. R. (Jet Propulsion Laboratory)
Abbott, P. W. (General Dynamics Corporation)
Technical Memorandum 33-389, May 1, 1969
(Unclassified)

In late 1966, the Jet Propulsion Laboratory conducted experiments using the structural test model of the Surveyor spacecraft to measure structural transfer functions significant to flight stability during the terminal descent phase. This technical memorandum describes the test program and the methods used for data processing. Illustrative transfer functions are presented as Bode plots. Suggestions are made for a mode of closed-loop testing using shaping networks, power amplifiers, and electrodynamic exciters to synthesize the thrust-vectoring transfer functions.

Ginsberg, L. J.

G04 PERFORMANCE OF A MARS SOFT LANDER WITH STAGED PROPULSION

Kelley, J. H., Ginsberg, L. J.
Technical Report 32-1311 (Unclassified)
(Reprinted from Journal of Spacecraft and Rockets, Vol. 5, No. 7, pp. 774–780, July 1968)

For abstract, see Kelley, J. H.

Goldstein, R.

G05 NUMERICAL CALCULATIONS OF ELECTRON—ATOM EXCITATION AND IONIZATION RATES USING GRYZINSKI CROSS SECTIONS

Goldstein, R.
Technical Report 32-1372, March 1, 1969
(Unclassified)

Electron–atom excitation and ionization rates were calculated numerically using Gryzinski classical cross-sections and Maxwellian electron distributions. A simple analytical expression was obtained which represents the calculations within ±5% over the physically most important range of electron temperatures and atomic parameters. Transition rates calculated from a linear approximation to the cross-sections are in poorer agreement with the exact values than this analytical expression.

Gonzalez, C. C.

G06 SOLAR PROTON FORECAST SYSTEM AND PROCEDURES USED DURING THE MARINER V MISSION

Gonzalez, C. C., Divita, E. L.
Technical Report 32-1303, October 1, 1968
(Unclassified)

A solar forecasting system and forecasting procedures for predicting the time of occurrence of solar proton events and the associated time-integrated proton flux on a real-time basis for the Mariner V mission are discussed. The solar forecasting system utilizes solar activity data obtained from solar observational networks and provided by the Space Disturbance Forecast Center (SDFC) at Boulder, Colorado. Since SDFC does not provide forecasts of proton events and their sizes on a real-time basis, statistical methods are developed, based on past solar cycle data, in order to use the solar activity data obtained on a real-time basis ·in predicting proton events and their sizes. The 2800-MHz radio burst energy is correlated with time-integrated proton flux. In addition, procedures for receiving data, making forecasts, and reporting the forecasts to the project on a real-time basis are described. Statistical uncertainties in the prediction method and uncertainties in the data are discussed, and their influence on the value of the predictions is evaluated. A brief history of the real-time forecasting of proton events using the method and procedures is presented. Finally, recommendations are made to improve forecasting techniques and forecast procedures for reliable and timely warnings of pending solar proton events and their sizes.

Gottlieb, P.

G07 A TELEVISION SCANNING SCHEME FOR A DETECTOR-NOISE-LIMITED SYSTEM

Gottlieb, P.
Technical Report 32-1291 (Unclassified)
(Reprinted from IEEE Transactions on Information Theory, Vol. IT-14, No. 3, May 1968, pp. 428–433)

The signal-to-noise ratio at a single-element detector scanning a television picture can be improved if the detector receives light from many picture elements simultaneously. This report describes a scanning reticle, with transparent and opaque elements chosen according to a binary biorthogonal sequence, that will provide an exact reproduction in the same

scanning time as a reticle scanning only one element at a time. For general pictures, the proposed system will require greater bandwidth, but for pictures consisting of only a few bright spots, the bandwidth can actually be compressed. This system provides a "quick look" picture in less than the usual scanning time, which is of particularly good fidelity if the original picture contains only a few bright spots.

Gram, M. B.

G08 DEVELOPMENT OF A CHEMICAL HEATER FOR A MARS ROUGH-LANDING CAPSULE
Gram, M. B.
Technical Report 32-1343, December 15, 1968
(Unclassified)

This report describes preliminary work performed on one version of a chemical heater, sized to provide one night of survivability for a Mars rough lander. The effects of the impact environment and heat sterilization requirement on the design are discussed. The resulting chemical heater utilizes chlorine trifluoride and boron reactants, weighs 3 lb, and has a heat yield of 1940 W-h.

Gronroos, H. G.

G09 A CONTROL SYSTEM STUDY FOR AN IN-CORE THERMIONIC REACTOR
Weaver, L. E., Gronroos, H. G., Guppy, J. G., Davis, J. P.
Technical Report 32-1355, January 15, 1969
(Unclassified)

For abstract, see Weaver, L. E.

Guppy, J. G.

G10 A CONTROL SYSTEM STUDY FOR AN IN-CORE THERMIONIC REACTOR
Weaver, L. E., Gronroos, H. G., Guppy, J. G., Davis, J. P.
Technical Report 32-1355, January 15, 1969
(Unclassified)

For abstract, see Weaver, L. E.

Harrell, J.

H01 THE 10-FT SPACE SIMULATOR AT THE JET PROPULSION LABORATORY
Alexander, W., Dyckman, L., Harrell, J., Nelson, W., Schaefle, W.
Technical Report 32-1231, Revision 1, January 15, 1969
(Unclassified)

For abstract, see Alexander, W.

Harstad, K. G.

H02 TRANSPORT EQUATIONS FOR GASES AND PLASMAS OBTAINED BY THE 13-MOMENT METHOD: A SUMMARY
Harstad, K. G.
Technical Report 32-1318, October 1, 1968
(Unclassified)

A summary of results obtained from 13-moment solutions to the Boltzmann equations for a gas mixture is presented. The simplifications that can be achieved when one of the components has a small mass are discussed. A calculation of electron–atom collision parameters for noble gas atoms with Ramsauer cross sections (A, Kr, Xe) is also given.

Hays, L. G.

H03 ANALYSIS OF A MULTISTAGE LIQUID-METAL MAGNETOHYDRODYNAMIC POWER CONVERSION CYCLE
Hays, L. G.
Technical Report 32-1371, April 1, 1969
(Unclassified)

A liquid-metal magnetohydrodynamic (MHD) power system with power extraction at several stages in the expansion process is discussed and analyzed. Cycle efficiency is shown to improve from the 6% range for a single-stage 1800°F system to the 10% range for a multistage 1800°F system. Cycle efficiency at 2000°F is slightly lower but a smaller radiator area is attainable than at 1800°F. The advantages of lower liquid-metal velocities and MHD generator redundancy are also possible in a multistage system.

Heacock, R. L.

H04 LUNAR PHOTOGRAPHY: TECHNIQUES AND RESULTS
Heacock, R. L.
Technical Report 32-1277 (Unclassified)
(Reprinted from *Space Science Reviews*, Vol. 8,
D. Reidel Publishing Company, Dordrecht, Holland 1968,
pp. 214–257)

A primary tool in the exploration of the moon has been photography. Due to the limitations imposed upon the various missions, the photographic techniques used have involved several specialized approaches. This report discusses these various approaches, the missions on which they were used, and the results which were achieved. The lack of detailed information available on the Soviet systems has severely limited the coverage of their efforts.

Heer, E.

H05 ANALYSIS OF SPACE VEHICLE STRUCTURES USING THE TRANSFER-FUNCTION CONCEPT
Heer, E., Trubert, M. R.
Technical Report 32-1367, April 1, 1969
(Unclassified)

In this report the concept of frequency transfer function is used for the analysis of space vehicle structures. The method of determining the dynamic response of a structural system from the subsystems' characteristics is reviewed and explored for applications to space vehicle systems. The basic problem is considered to be that of joining together and determining the dynamic response of a number of subsystems

that may be excited by deterministic and/or stationary random multiple inputs. The subsystems may represent, for instance, a launch vehicle, a spacecraft, an entry capsule, and a lander system. They may also represent a structure under test and a system of shakers that substantially influence the experimental results during dynamic testing, the effects of which are to be eliminated so that the true transfer functions can be obtained. The specific objectives of this report are to present a unifying and general picture of the transfer-function technique and to illustrate with a number of examples its practical utility in actual situations as they have been encountered at the Jet Propulsion Laboratory.

H06 RECEPTANCE COUPLING OF STRUCTURAL COMPONENTS NEAR A COMPONENT RESONANCE FREQUENCY
Lutes, L. D., Heer, E.
Technical Memorandum 33-411, October 15, 1968
(Unclassified)

For abstract, see Lutes, L. D.

Hibbs, A. R.

H07 LUNAR EXPLORATION: THE IMPACT OF RANGER AND SURVEYOR RESULTS
Stewart, H. J., Hibbs, A. R., Conel, J. E., Rindfleisch, T.
Technical Report 32-1399 (Unclassified)
(Reprinted from Astronautics and Aeronautics, Vol. 7, No. 1, January 1969)

For abstract, see Stewart, H. J.

Hicks, W. W.

H08 DOCUMENTATION OF WIRING HARNESSES BY USE OF PUNCHED-CARD TECHNIQUES
Kloezeman, W. G., Hicks, W. W.
Technical Report 32-1326, October 15, 1968
(Unclassified)

For abstract, see Kloezeman, W. G.

Higa, W.

H09 THE ULTRA CONE: AN ULTRA-LOW-NOISE SPACE COMMUNICATION GROUND RADIO-FREQUENCY SYSTEM
Levy, G. S., Bathker, D. A., Higa, W., Stelzried, C. T.
Technical Report 32-1340 (Unclassified)
(Reprinted from IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-16, No. 9, pp. 596–602, September 1968)

For abstract, see Levy, G. S.

Hix, J. H.

H10 A PARAMETRIC STUDY OF VARIATIONS IN WEIGHT AND PERFORMANCE CHARACTERISTICS OF LARGE-AREA SOLAR ARRAYS
Oliver, R. E., Garba, J. A., Hix, J. H.
Technical Report 32-1337, March 1, 1969
(Unclassified)

For abstract, see Oliver, R. E.

Horton, T. E.

H11 A PROGRAM FOR COMPUTING SHOCK-TUBE GASDYNAMIC PROPERTIES
Horton, T. E., Menard, W. A.
Technical Report 32-1350, January 15, 1969
(Unclassified)

A computer program for calculating the chemical equilibrium properties associated with moving, standing, and reflected normal shocks has been developed. The program calculates thermodynamic properties and chemical composition from basic spectroscopic data. Both dissociation and ionization over an unlimited temperature range can be considered. The chemical equilibrium and composition equations are developed from statistical mechanics, and the procedure for solving the coupled equilibrium and normal shock equations is presented. Flow diagrams, operating instructions, and listings of the program and input data are included. The program can treat initial mixtures consisting of up to ten gases. In this report, input data are listed for 66 species which are composed of carbon, nitrogen, oxygen, hydrogen, argon, neon, and helium.

Houseman, J.

H12 CRITERIA FOR SEPARATION OF IMPINGING STREAMS OF HYPERGOLIC PROPELLANTS
Kushida, R., Houseman, J.
Technical Memorandum 33-395, July 15, 1968
(Unclassified)

For abstract, see Kushida, R.

Jaffe, P.

J01 ENTRY DYNAMICS OF A SPINNING VEHICLE
Prislin, R. H., Jaffe, P.
Technical Memorandum 33-398, August 15, 1968
(Unclassified)

For abstract, see Prislin, R. H.

Jet Propulsion Laboratory

J02 PROCEEDINGS OF THE 3RD AEROSPACE MECHANISMS SYMPOSIUM
Jet Propulsion Laboratory
Technical Memorandum 33-382, October 1, 1968
(Unclassified)

The 3rd Aerospace Mechanisms Symposium was held at the Jet Propulsion Laboratory, California Institute of Technology, on May 23–24, 1968. It was sponsored by the University of Santa Clara, Lockheed Missiles and Space Company, and the Jet Propulsion Laboratory. The symposium brought together approximately 300 representatives from 68 organizations concerned with the use of mechanisms in space; the attendees came from many areas of the United States and Canada, representing industry, universities, and various government agencies.

J03 PROCEEDINGS OF THE SPACECRAFT ELECTROMAGNETIC INTERFERENCE WORKSHOP
Jet Propulsion Laboratory
Technical Memorandum 33-402, December 15, 1968
(Unclassified)

A Spacecraft Electromagnetic Interference Workshop was held at JPL during February 6–8, 1968, to permit an exchange of ideas and experiences peculiar to the design, integration, testing, and operation of spacecraft. Presentations at the workshop by spacecraft and launch-vehicle engineers and experimenters revealed a disparity among the various concepts of spacecraft electromagnetic interference.

For the majority of the papers presented, formal manuscripts were furnished for publication in the proceedings. The other presentations were obtained from recordings made at the workshop. Similarly, supplemental remarks made by the various authors and the questions and discussions from the audience have been extracted from these recordings for publication.

Kalfayan, S. H.

K01 STUDIES ON ETHYLENE OXIDE–FREON 12 DECONTAMINATION AND DRY-HEAT STERILIZATION CYCLES
Kalfayan, S. H., Silver, R. H., Campbell, B. A.
Technical Report 32-1310, August 15, 1968
(Unclassified)

Several problems related to the ethylene oxide–Freon 12 decontamination process were investigated, including: (1) the quantitative estimation of the ethylene oxide concentration in the decontamination chamber, (2) the possibility of reaction between the gases present in the decontamination chamber, (3) the establishment of adequate air-flushing periods to dissipate the absorbed sterilant gases from the materials, and (4) the determination of moisture content. Results show that (1) gas chromatography can be employed as an analytical method for the quantitative estimation of ethylene oxide, with fairly good accuracy, (2) ethylene glycol and small amounts of HCl are formed in the decontamination chamber, (3) air-flushing periods should be extended to 8 h or more for the effective dissipation of absorbed sterilant gases, and (4) none of the commercial moisture-sensing instruments are satisfactory for determining the relative humidity in an atmosphere of ethylene oxide–Freon 12.

The effect of various dry-heat sterilization cycles on a selected number of polymeric materials was also investigated, and the results were compared with those obtained for dry-heat sterilization set forth in the JPL specification. Indications were that polymeric materials exposed to higher temperatures for shorter periods (155°C for 240 h) were more affected than by exposure to lower temperatures for longer periods (105°C for 3600 h) Polymeric materials of known heat resistance were not so affected. Also, the presence of small quantities of oxygen(0.45%) in the dry-heat sterilization chamber did not significantly affect the property changes of the exposed polymeric materials.

Keeler, L. H.

K02 ELECTROMAGNETIC INTERFERENCE ASPECTS OF INTEGRATING A UHF/VHF RECEIVER ONBOARD MARINER V
Case, R. K., Keeler, L. H.
Technical Report 32-1315, November 1, 1968
(Unclassified)

For abstract, see Case, R. K.

Kelley, J. H.

K03 PERFORMANCE OF A MARS SOFT LANDER WITH STAGED PROPULSION
Kelley, J. H., Ginsberg, L. J.
Technical Report 32-1311 (Unclassified)
(Reprinted from Journal of Spacecraft and Rockets, Vol. 5, No. 7, pp. 774–780, July 1968)

A parametric study was conducted to determine the performance of a Mars soft lander utilizing two distinct thrust levels during the terminal phase of an out-of-orbit entry. The analysis is applicable to a vehicle descending along a trajectory governed by a gravity turn maneuver. With the residual landed fraction as the performance criterion, the superiority of the dual thrust-level concept as compared to single thrust-level model was demonstrated and tabulated. Entry conditions, atmospheric profile, ballistic coefficient, thrust levels, and entry mass were the variables used in determining optimum ignition altitudes for both the single and dual thrust-level systems. Although a solid-propellant motor was used in this investigation, the dual thrust-level concept is by no means constrained to such application. The mathematical structure requires only a discontinuity in the thrust level without regard to its source.

Kerner, T.

K04 GRAVITY-GRADIENT EFFECTS ON AN ATTITUDE-CONTROLLED SATELLITE
Kerner, T.
Technical Memorandum 33-409, October 15, 1968
(Unclassified)

A spacecraft orbiting about a planet is normally subject to torques caused by gravity-gradient effects. Studies of missions involving orbiting spacecraft require that these torques be

analytically described. This report describes a derivation that results in expressions to describe these torques. The gas weight required to offset these torques for a *Mariner*-type attitude-controlled spacecraft is also derived; the results are directly applicable to *Mariner* Mars 1971 gas budget sizing.

Kerr, W. R.

K05 BASE PRESSURE DISTRIBUTION OF TWO BLUNTED CONES AT MACH NUMBERS FROM 0.3 TO 0.8 AND 1.81 TO 3.51
Kurtz, D. W., Kerr, W. R.
Technical Memorandum 33-403, October 15, 1968
(Unclassified)

For abstract, see Kurtz, D. W.

Kirk, D. E.

K06 A PATH-FINDING ALGORITHM FOR AN UNMANNED ROVING VEHICLE
Kirk, D. E.
Technical Report 32-1369, May 15, 1969
(Unclassified)

Plans for future space missions include an unmanned roving vehicle designed to explore the Martian surface. Because of the long transit times required for the transmission of TV information from Mars to earth, control of the vehicle by an earth-based operator viewing a TV picture of the terrain is not feasible. As a result, the vehicle is to be controlled by an on-board computer. This report discusses a proposed routing algorithm which utilizes gross terrain information to determine a nominal optimal path from some initial point to a specified destination.

Kizner, W.

K07 OPTIMAL NONLINEAR ESTIMATION BASED ON ORTHOGONAL EXPANSIONS
Kizner, W.
Technical Report 32-1366, April 15, 1969
(Unclassified)

This report is concerned with the statistical optimal estimation of parameters x of nonlinear systems. If a quadratic loss function is used, then the conditional mean of x, given the observations and *a priori* information, is used. The conditional mean is calculated using an n-dimensional Gram–Charlier expansion of the *a posteriori* probability density function. A numerical method for finding this distribution is given, and some of its properties are discussed, including the case for which the method is optimal.

If a more general kind of loss function is used and a mean-square approximation to the *a posteriori* probability density function is desired, a Hermite function expansion which converges in the mean square is employed. Again, numerical methods are given for finding the coefficients of the expansion, and the optimality of this other procedure is discussed.

Kloezeman, W. G.

K08 DOCUMENTATION OF WIRING HARNESSES BY USE OF PUNCHED-CARD TECHNIQUES
Kloezeman, W. G., Hicks, W. W.
Technical Report 32-1326, October 15, 1968
(Unclassified)

This report discusses a technique for using a punched-card printer to produce wiring harness documentation. A format for punching the required information on the cards and a method for sorting the resulting cards in preparation for printing are covered. Also, the printing format and the wiring of the printer control panel are discussed.

Knoell, A. C.

K09 LANDING DYNAMICS PROGRAM FOR AXISYMMETRIC IMPACT ATTENUATING VEHICLES (LANDIT)
Knoell, A. C.
Technical Report 32-1341, November 15, 1968
(Unclassified)

A computer program is described that predicts the dynamic landing response characteristics of axisymmetric impact attenuating vehicles consisting of a rigid payload and a crushable impact limiter system. The program is based on the solution of a planar landing dynamics problem considering vehicle impacts against plane unyielding surfaces. Initial conditions that must be provided include impact velocity vector, touchdown angle, vehicle pitch rate, surface slope, and coefficient of friction.

K10 A MATERIALS-DESIGN SYNTHESIS FOR OPTIMUM DESIGN OF SPACECRAFT ENERGY-DISSIPATING SYSTEMS
Knoell, A. C.
Technical Report 32-1346 (Unclassified)
(Reprinted from *Journal of Spacecraft and Rockets*, Vol. 5, No. 10, pp. 1170–1174, October 1968)

The statement and mathematical formulation of the extremum problem associated with the optimum design of spacecraft impact limiters (payload plus energy dissipator) are presented. Methods of solution are discussed and a semi-geometric solution is given. It is shown that, in general, a practical rather than a true maximum for the objective function, developed as the payload fraction, exists in the solution domain. In developing the practical maximum, it is shown that energy dissipators having high specific energy capacities (energy dissipated per pound of material) are best suited for achieving an optimum system design.

Koerner, M. A.

K11 EFFECT OF INTERFERENCE ON A BINARY COMMUNICATION CHANNEL USING KNOWN SIGNALS
Koerner, M. A.
Technical Report 32-1281, December 1, 1968
(Unclassified)

This report presents the results of an analysis of the effects of sinusodial and gaussian interference on the performance of the maximum-likelihood receiver for extracting binary data from a sequence of messages in white gaussian noise when each signal has duration T and is chosen with equal a priori probability from a dictionary of two messages. The report presents equations for the receiver error probability and the receiver degradation as a function of the parameters λ and η or ξ. Graphs are included which show the behavior of the receiver error probability and the receiver degradation as a function of $10 \log \lambda$ and $10 \log \eta$ or $10 \log \xi$. Equations are presented which relate the parameters λ, η, and ξ to the basic parameters of the signal, interference, and noise. Finally, comparison is made of the effect of a sinusoidal interfering signal with that of a gaussian interfering signal. The comparison shows that for small values of λ and η or ξ, the degradation produced by sinusoidal interference is close to that produced by gaussian interference. However, the approximation is not valid for large λ or large η or ξ.

Kopf, E. H.

K12 A MARINER ORBITER AUTOPILOT DESIGN
Kopf, E. H.
Technical Report 32-1349, January 15, 1969
(Unclassified)

An autopilot for a planetary orbiter is described. Autopilot design problems and parameters, and autopilot/spacecraft interfaces are defined.

Kurtz, D. W.

K13 BASE PRESSURE DISTRIBUTION OF TWO BLUNTED CONES AT MACH NUMBERS FROM 0.3 TO 0.8 AND 1.81 TO 3.51
Kurtz, D. W., Kerr, W. R.
Technical Memorandum 33-403, October 15, 1968
(Unclassified)

To determine the detailed base pressure distribution on two blunted cones, a wind tunnel test was conducted in the JPL supersonic wind tunnel. The two models, a 60-deg half-angle cone and a 45-deg half-angle cone, were investigated through a Mach number range of 0.3 to 0.8 and 1.81 to 3.51 at angles of attack of 0 to 20 deg. The subsonic wake shape and base pressure were highly insensitive to body shape and angle of attack changes in the range investigated. At supersonic Mach numbers, the base pressure was a distinct function of the wake-neck diameter, which decreased with increasing Mach number. The Reynolds number had a distinct influence on the

viscous mixing and wake boundary layer. In the transition region from laminar to turbulent wake, an increase in the Reynolds number resulted in a reduction in the base pressure ratio.

K14 DETAILED PRESSURE DISTRIBUTION ON A BLUNTED 60-deg HALF-ANGLE CONE AT MACH NUMBERS OF 6.08 AND 9.46
Kurtz, D. W.
Technical Memorandum 33-404, September 1, 1968
(Unclassified)

An investigation of the detailed pressure distribution on a spherically blunted 60-deg half-angle cone was conducted in the hypersonic wind tunnel at JPL. Tests indicated that the pressure coefficient distribution over the surface seemed to be almost independent of Mach number at Mach numbers of 6.08 and 9.46. At both Mach numbers, the nose pressure remained within a band of 3% through angles of attack from 0 to 6 deg. Beyond 2 deg, the displacement of the stagnation point from the longitudinal body axis was not a linear function of angle of attack. Although base pressures were measured, they are not included because support interference yielded questionable data.

Kushida, R.

K15 THEORY OF LAMINAR FLAMES IN STAGNATION FLOWS
Kushida, R.
Technical Report 32-1261, July 15, 1968
(Unclassified)

The theory of laminar flames sustained in a burner where combustibles are injected through two parallel, opposed porous walls is considered. For steady flow at low Mach numbers, similar solutions of the type found applicable to stagnation flow permit the reduction of the general equations of change to a set of one-dimensional equations. The classic one-dimensional flame equations of Hirschfelder are obtained in a limiting case where the rate of injection from one surface is just equal to the rate of suction at the other surface.

Several examples of combustion experiments done in an apparatus which seems to approximate the ideal configuration have been previously reported. The flat flame diffusion burner of Pandya and Weinberg was the prototype burner on which the analysis was based. Several other burners not previously recognized to exhibit similar solutions are pointed out. One example is the premixed flat flame burner in which there is flow divergence because of a screen or flat plate placed in the burnt gas flow. The experiments of Schultz where solid pellets are vaporized by pressing against a hot plate can be analyzed by this technique.

K16 CRITERIA FOR SEPARATION OF IMPINGING STREAMS OF HYPERGOLIC PROPELLANTS
Kushida, R., Houseman, J.
Technical Memorandum 33-395, July 15, 1968
(Unclassified)

Two theoretical models of stream separation in impinging unlike doublets are advanced. These models are complementary, in that one applies at low pressure and the other at relatively higher pressures. The first model is based on the attainment of the bubble-point temperature at the stagnation point of the jets. In the second model, for higher pressures, the gas phase reactions become so rapid that an insulating gas film can be formed between the two impinging liquid jets, preventing any contact between liquid phases.

Using available data on rates of reaction for the N_2O_4–N_2H_4 propellant combination, estimates of the region where stream separation would or would not occur have been made. Curves based on the bubble-point limitation depend strongly on the variation of vapor pressure with propellant feed temperature. The gas film model exhibits no such dependence. The $-3/2$ power dependence on pressure of this latter model is due to the sensitivity of gas phase reactions to pressure. The theory is equally applicable to round jet and to flat sheet injector elements. The experimental data obtained at JPL appear to correlate with the theory, in that the smaller-diameter injectors (less than 0.02 in.) show no stream separation, but the larger ones (greater than 0.06 in.) do.

Labrum, R. G.

L01 THE SURVEYOR III AND SURVEYOR IV FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
O'Neil, W. J., Labrum, R. G., Wong, S. K.,
Reynolds, G. W.
Technical Report 32-1292, August 15, 1968
(Unclassified)

For abstract, see O'Neil, W. J.

L02 THE SURVEYOR V, VI, AND VII FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
Labrum, R. G., Wong, S. K., Reynolds, G. W.
Technical Report 32-1302, December 1, 1968
(Unclassified)

To determine the current best estimates of the Surveyor V, Surveyor VI, and Surveyor VII flight paths, tracking data from DSSs 11, 42, 51, 61, and 72 were analyzed. Significant blocks of bad data were detected and eliminated from the final solutions. Various combinations of parameters were estimated to achieve the best possible fit of the data with realistic orbit parameters. The current best estimates indicate that Surveyors V, VI, and VII landed 31.7, 6.9, and 4.2 km, respectively, from their final aim points. Landed locations estimated by analysis of post-touchdown data and Lunar Orbiter photographs are also presented for comparison. Deep space station locations, $GM_\oplus$, and $GM_{\mathbb{C}}$ were determined from Surveyor tracking data and agree quite well with the solutions obtained from analysis of Ranger data. JPL postflight analysis of AFETR tracking data supplied during the near-earth phase of the Surveyor missions confirms the adequacy of the inflight solutions provided.

Lardenoit, V. F.

L03 APPLICATION OF ELECTRON AND LASER BEAMS TO SPACECRAFT ELECTRONIC JOINING
Lardenoit, V. F.
Technical Memorandum 33-396, September 15, 1968
(Unclassified)

A survey was made of electron beam and laser techniques as applicable to spacecraft electronic joining. A brief description is presented, of conventional and advanced joining techniques requiring contact between the parts to be joined and the joining equipment, for comparison to focused energy devices that do not require contact. Advantages and disadvantages of the laser and electron-beam devices are discussed, as is device operation.

Results of evaluation tests as well as typical applications for both laser and electron beam welders are presented. Certain data and applications were not available due to their proprietary nature. The information was obtained through literature reviews and discussions with manufacturers and users of these devices. New developments and required improvements are also briefly discussed.

Lecoq, P. E.

L04 A COMPUTER PROGRAM FOR SIMPLIFYING INCOMPLETELY SPECIFIED SEQUENTIAL MACHINES USING THE PAULL AND UNGER TECHNIQUE
Ebersole, M. M., Lecoq, P. E.
Technical Report 32-997, November 15, 1968
(Unclassified)

For abstract, see Ebersole, M. M.

Le Croissette, D. H.

L05 THE SCIENTIFIC INSTRUMENTS ON SURVEYOR
Le Croissette, D. H.
Technical Report 32-1358 (Unclassified)
(Reprinted from IEEE Transactions on Aerospace and Electronic Systems, Vol. AES-5, No. 1, pp. 2–21, January 1969)

The Surveyor Program of the National Aeronautics and Space Administration successfully soft-landed five spacecraft on the surface of the moon between June 2, 1966, and January 10, 1968. Three scientific instruments were developed specifically for this program and were carried by one or more spacecraft to the lunar surface. A 600-line television camera was used on all five spacecraft and returned nearly 90,000 pictures from the moon. An alpha-scattering instrument, designed for this program, was successfully operated on the lunar surface to give the first elemental analysis of the lunar topsoil. This instrument was carried on three spacecraft and made an analysis of six lunar samples. A surface sampler was also mounted on two of the spacecraft and was used to manipulate the moon's surface, allowing the first estimate to be made of the mechanical properties of the top few inches of

lunar surface. This paper describes each of the three instruments and assesses their capabilities. An outline of their operation on the lunar surface is also given.

Lesh, H. F.

L06 DETERMINATION OF INTERPLANETARY TRAJECTORIES
Lesh, H. F.
Technical Memorandum 33-414, November 1, 1968
(Unclassified)

This document presents in the simplest possible language the fundamental ideas involved in calculating the flight paths of lunar and planetary spacecraft. The mathematics are kept relatively simple and complex ideas are clarified by the use of diagrams. The memorandum will be useful to the technically educated person who wants to understand basic trajectory theory.

Levy, G. S.

L07 THE ULTRA CONE: AN ULTRA-LOW-NOISE SPACE COMMUNICATION GROUND RADIO-FREQUENCY SYSTEM
Levy, G. S., Bathker, D. A., Higa, W., Stelzried, C. T.
Technical Report 32-1340 (Unclassified)
(Reprinted from *IEEE Transactions on Microwave Theory and Techniques*, Vol. MTT-16, No. 9, pp. 596–602, September, 1968)

Maximum sensitivity was required for the reception of the signals of *Mariner V* as it was occulted by the planet Venus. To meet this requirement, an ultra-low-noise front end (S-band cassegrain feed cone: *ultra cone*) was developed for an 85-ft antenna of the JPL/NASA Deep Space Instrumentation Facility. The cone structure contained a feed horn, polarizer, maser, closed-cycle cryostat, and appropriate transmission line and calibration equipment. The overall low-noise system consisted of an 85-ft antenna with a cassegrain feed, low-noise transmission line components, and closed-cycle refrigerated maser amplifier. The antenna (at zenith), transmission line, and maser contributed about 9, 2, and 5°K, respectively, for a total operating noise temperature of approximately 16°K. The antenna feed, maser system, and calibration techniques are described in detail.

Lim, L. Y.

L08 A PATHFINDING ALGORITHM FOR A MYOPIC ROBOT
Lim, L. Y.
Technical Report 32-1288, August 1, 1968
(Unclassified)

A pathfinding algorithm has been developed for an autonomous myopic roving vehicle. With the assumption that a path exists between two points, two propositions are proved. Proposition 1 is concerned with no obstacles and proposition 2 is concerned with at least one obstacle. Various conditions are established and terms defined. Three algorithms necessary to direct the robot are main, left scan, and right scan.

The decisions for the navigation, control, and obstacle avoidance of the rover are based mainly on myopic (local) information of the terrain. The use of gaussian density functions to simulate topography is considered to be novel. A Fortran IV computer program was written to implement the pathfinding algorithm, and the results of the computer–program runs were satisfactory.

Lindsey, W. C.

L09 SUBCARRIER TRACKING METHODS AND COMMUNICATION SYSTEM DESIGN
Didday, R. L., Lindsey, W. C.
Technical Report 32-1317 (Unclassified)
(Reprinted from *IEEE Transactions on Communication Technology*, Vol. COM-16, No. 4, pp. 541-550, August 1968)

For abstract, see Didday, R. L.

Liu, A. S.

L10 THE *RANGER IX* FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.
Technical Report 32-767, November 1, 1968
(Unclassified)

For abstract, see Vegos, C. J.

Locke, J. R.

L11 COMPUTER-AIDED ANALYSIS OF A PEAK DETECTOR AND ANALOG-TO-PULSE-WIDTH CONVERTER
Overbey, J. L., Locke, J. R.
Technical Memorandum 33-401, March 15, 1969
(Unclassified)

For abstract, see Overbey, J. L.

Lorell, J.

L12 *LUNAR ORBITER* GRAVITY ANALYSIS
Lorell, J.
Technical Report 32-1387, June 15, 1969
(Unclassified)

This report presents the results to date of the JPL effort at analyzing the tracking data from the five *Lunar Orbiter* spacecraft. Emphasis is placed on the long-arc evaluation, toward which most of the work was directed, rather than on mascon analysis, which will be reported separately.

The model of the moon's gravity field that has been derived from the long-arc analysis is interpreted in terms of the moon's mass distribution. The results are evaluated from the point of view of consistency and of statistical significance. In particular, the various factors contributing to the uncertainty in the estimation process are discussed.

Loucks, R. E.

L13 POWER SYSTEM DESIGN FOR A JUPITER SOLAR ELECTRIC PROPULSION SPACECRAFT
Truscello, V. (Jet Propulsion Laboratory)
Loucks, R. E. (TRW Systems)
Technical Report 32-1347, October 15, 1968
(Unclassified)

For abstract, see Truscello, V.

Lutes, L. D.

L14 RECEPTANCE COUPLING OF STRUCTURAL COMPONENTS NEAR A COMPONENT RESONANCE FREQUENCY
Lutes, L. D., Heer, E.
Technical Memorandum 33-411, October 15, 1968
(Unclassified)

The receptance matrix of a coupled system is derived in terms of the receptance properties of the individual component systems and coupling links. It is then shown that the resulting matrix equation may give quite inaccurate results near a resonance frequency of an individual component system where the receptance matrices for that component have large, nearly parallel columns. A formulation of the problem is given in terms of matrices with the large, parallel parts of the columns removed, thus avoiding the inaccuracy difficulty with very little additional computation. The formulation is valid for systems with damping, since all receptance terms are treated as complex numbers.

Mackin, R. J., Jr.

M01 SCIENTIFIC QUESTIONS FOR THE EXPLORATION OF THE TERRESTRIAL PLANETS AND JUPITER. A PROGRESS REPORT OF THE ADVANCED PLANETARY MISSIONS TECHNOLOGY PROGRAM
Mackin, R. J., Jr.,et al.
Technical Memorandum 33-410, October 1, 1968
(Unclassified)

This report is one of a series directed toward providing a scientific basis for priority ordering of experiments for planetary missions in the 1970s. The approach is evaluated of the potential of experiments and missions for answering questions bearing on the key scientific goals of the planetary program, viz understanding the origin and evolution of the solar system and the distribution and role of life in the solar system. A prior document developed a list of general questions whose answers would give the key to the course of solar system history at crucial points.

The present report lists the questions concerning each individual planet which bear upon the more general questions or upon similar questions concerning life. For orientation, the chapter on each planet begins with a resume of the current state of knowledge of that planet. This is followed by a projection of some of the advances in knowledge expected by 1971. Finally, a list of questions on the planet is presented, each with remarks on the implications of the question and with a discussion of the types of experiments that will contribute toward answering the question. Several Appendixes treat topics considered worthy of some amplification.

Mariner Venus 67 Project

M02 MARINER VENUS 67 FINAL PROJECT REPORT: VOLUME I. LAUNCH THROUGH MIDCOURSE MANEUVER
Mariner Venus 67 Project
Technical Report 32-1203, June 15, 1968
(Unclassified)

This document covers the launch through the midcourse maneuver of Mariner V, the flight spacecraft of the Mariner Venus 67 project. Included in this document are a brief history of Mariner projects, the project objectives of Mariner Venus 67, and the mission description and characteristics of the Mariner Venus 67 project. Also included are sections on the overall project organization and management, the flight path analysis and mission planning, the spacecraft system, the launch vehicle integration, the mission operations system, and the mission-analysis preparations and activities during countdown and launch.

M03 MARINER VENUS 67 FINAL PROJECT REPORT: VOLUME II. MIDCOURSE MANEUVER THROUGH END OF MISSION
Mariner Venus 67 Project
Technical Report 32-1203, May 1, 1969
(Unclassified)

Volume I of this report described the Mariner Venus 67 mission from launch to the midcourse maneuver; in this volume, mission planning, operations, and performance are discussed from the midcourse maneuver (which was commanded at 03:00 GMT on June 19, 1967) to the project-defined end of mission (Phase I) on December 1, 1967. Recommendations for modifications affecting organization, software, etc., are included for possible use on future space missions of a similar type.

M04 MARINER VENUS 67 EXTENSION: FINAL PROJECT REPORT
Mariner Venus 67 Project
Technical Memorandum 33-421, June 15, 1969
(Unclassified)

This technical memorandum describes the plans and activities undertaken to achieve the objectives of the Mariner Venus 67 Extension Project. Acquisition attempts for a nominal spacecraft were started on April 26, 1968; five such

attempts were made with no results. A successful reacquisition was accomplished on October 14, 1968; however, the spacecraft exhibited anomalous behavior in both signal strength and stability. The techniques and procedures used in each acquisition attempt are discussed in this memorandum, as are all possible failure modes of a catastrophic and non-catastrophic nature that might have led to the anomalous behavior of *Mariner V*.

Martin, D. P.

M05 MARINER V DUAL-FREQUENCY RECEIVER
Martin, D. P.
Technical Report 32-1375, April 15, 1969
(Unclassified)

This report summarizes the development and performance of the dual-frequency receiver (DFR), an instrument which was used in one of the science experiments on the *Mariner V* mission to Venus. The objective of the experiment was to measure the effects of the atmosphere of Venus on the radio waves received by the DFR as the spacecraft occulted the planet. The experiment's method and equipment are described, the development tests and some of the problems encountered are discussed, and the flight performance is summarized.

Masek, T. D.

M06 EXPERIMENTAL STUDIES WITH A MERCURY BOMBARDMENT THRUSTOR SYSTEM
Masek, T. D.
Technical Report 32-1280, July 15, 1968
(Unclassified)

Tests performed with a mercury-electron-bombardment ion engine system are discussed in this report. The total assembly is composed of four 2.5-kW thrustors, individual isolated feed systems, and two 200-lb capacity propellant tankage systems. The thrustors, nominally 20 cm in diam, utilize a reverse-feed propellant introduction method, electromagnets, and oxide cathodes. The propellant tankage uses a neoprene expulsion bladder pressurized by Freon. Preliminary tests showed that all components operated satisfactorily and a system power-to-thrust ratio of about 120 kW/lb was achieved at about 3500 s, specific impulse. These experiments show that with modest optimization, a basic propulsion system design would be suitable for advanced system development.

Massier, P. F.

M07 HEAT-TRANSFER MEASUREMENTS IN THE SHOCK-INDUCED FLOW SEPARATION REGION IN A SUPERSONIC NOZZLE
Back, L. H., Massier, P. F., Cuffel, R. F.
Technical Report 32-1278 (Unclassified)
(Reprinted from *AIAA Journal*, Vol 6, No. 5, May 1968, pp. 923–925)

For abstract, see Back, L. H.

McKown, P. M.

M08 A METHOD FOR CALCULATING STEADY-STATE THRUST AND FLOW-RATE LEVELS FOR MARINER IV TYPE ATTITUDE CONTROL NITROGEN GAS JETS
Ferrera, J. D., McKown, P. M.
Technical Report 32-1353, December 1, 1968
(Unclassified)

For abstract, see Ferrera, J. D.

Melbourne, W. G.

M09 CONSTANTS AND RELATED INFORMATION FOR ASTRODYNAMIC CALCULATIONS, 1968
Melbourne, W. G., Mulholland, J. D.
Sjogren, W. L., Sturms, F. M., Jr.
Technical Report 32-1306, July 15, 1968
(Unclassified)

The principal constants and related information used in space trajectory and navigation calculations are discussed. The values of these constants presently adopted at JPL are described and estimates of their accuracy are provided.

Menard, W. A.

M10 A PROGRAM FOR COMPUTING SHOCK-TUBE GASDYNAMIC PROPERTIES
Horton, T. E., Menard, W. A.
Technical Report 32-1350, January 15, 1969
(Unclassified)

For abstract, see Horton, T. E.

Metzger, A. E.

M11 PERFORMANCE OF A BREADBOARD ELECTRONICS SYSTEM DEVELOPED FOR A LUNAR ORBITER GAMMA RAY SPECTROMETER
Metzger, A. E.
Technical Report 32-1297, October 1, 1968
(Unclassified)

An electronics system intended to be part of a remote-sensing gamma ray spectrometer has been designed and constructed. This report describes the system and a series of evaluation tests performed on the breadboard model. Results of the test program have been satisfactory.

Moss, R.

M12 EFFECTS OF ENVIRONMENTAL EXPOSURES ON SILICON SOLAR CELLS
Moss, R., Berman, P.
Technical Report 32-1362, January 15, 1969
(Unclassified)

A series of environmental tests was performed on batches of silicon solar cells having titanium-silver contacts, with and

without solder coating, to determine the effects of these environments on the mechanical and electrical properties of the cells. Cells with solder coating exhibited the largest electrical and mechanical degradations after exposure to a series of five thermal cycles from $+135$ to $-196°C$ while cells without solder coating exhibited the largest mechanical degradations after a 36-h exposure at 145°C. This latter exposure, however, did not result in significant electrical degradation. Thus, the presence of solder coating on solar cells can have a protective or deleterious effect, depending upon the environment. It was observed that either solder-coated or non-solder-coated cells were capable of surviving all the environmental tests with essentially no degradation, indicating that problems were in the process controls rather than in the basic cell process. Analysis indicated that, in the case of solder-coated cells, the major problem was in the control of solder thickness and uniformity. In the case of non-solder-coated cells, the major problem area was not identified; however, it is postulated that more than one mechanism is operating since it was not possible to correlate electrical degradation with contact pull-strength degradation.

Mulholland, J. D.

M13 GRAVITATIONAL INCONSISTENCY IN THE LUNAR THEORY: NUMERICAL DETERMINATION
Mulholland, J. D., Devine, C. J.
Technical Report 32-1290, Part I (Unclassified)
(Reprinted from Science, Vol. 160, May 24, 1968, pp. 874–875)

Preliminary numerical integrations of the lunar motion indicate that defects in the lunar ephemeris, due to omissions in the revised Brown lunar theory, produce errors of the order of several hundred m in the coordinates at certain times. Such errors are large enough to adversely affect analyses of data from spacecraft, as well as determination of ephemeris time. Distinct planetary periodicities seem to appear in the residuals.

M14 CONSTANTS AND RELATED INFORMATION FOR ASTRODYNAMIC CALCULATIONS, 1968
Melbourne, W. G., Mulholland, J. D.
Sjogren, W. L., Sturms, F. M., Jr.
Technical Report 32-1306, July 15, 1968
(Unclassified)

For abstract, see Melbourne, W. G.

M15 JPL LUNAR EPHEMERIS NUMBER 6
Mulholland, J. D.
Technical Memorandum 33-408, October 15, 1968
(Unclassified)

A revised lunar ephemeris has been constructed by applying a further correction to JPL Lunar Ephemeris 4. This correction completes the process of introducing all of the accessible theoretical corrections to the Brown lunar theory. It consists of the application of series terms, based on work by G. W. Hill, to adjust the coordinates to be compatible with the modern value of the earth's dynamical form factor J_2. The correction expressions are given and their application discussed. The accuracy of Lunar Ephemeris 6 is estimated, based on experience with Lunar Ephemeris 4 and on subsequent ephemeris improvement efforts.

Muller, P. M.

M16 CONSISTENCY OF LUNAR ORBITER RESIDUALS WITH TRAJECTORY AND LOCAL GRAVITY EFFECTS
Muller, P. M., Sjogren, W. L.
Technical Report 32-1307, September 1, 1968
(Unclassified)

The fits to earth-based coherent two-way radio doppler data from the Lunar Orbiters have consistently yielded residuals three orders of magnitude larger than the 0.1 mm/s normally observed with spacecraft at lunar distance. An intensive analysis of this problem has demonstrated a 1:1 correlation between residuals and position on the lunar track that eliminates other forces, and ties the residuals to local lunar gravity effects. The possibility that software was inducing the variations was eliminated by duplicating the residuals with a polynomial fit to the raw data. The results suggest need for a new or modified approach to the lunar potential model that would include one or more of the following characteristics: (1) higher order spherical harmonics, (2) point mass grid solutions, (3) direct mapping of residual-accelerations to the lunar surface.

M17 MASCONS: LUNAR MASS CONCENTRATIONS
Muller, P. M., Sjogren, W. L.
Technical Report 32-1339 (Unclassified)
(Reprinted from Science, Vol. 161, No. 3842, pp. 680–684, August 16, 1968)

Lunar Orbiter tracking data have been processed to supply a qualitatively consistent gravimetric map of the lunar nearside. While a simplified model was employed, the results indicate that there are large mass concentrations under the lunar ringed maria. These mass concentrations may have important implications for the various theories regarding lunar history.

Murphy, A. J.

M18 FIRING SQUIBS BY LOW-VOLTAGE CAPACITOR DISCHARGE FOR SPACECRAFT APPLICATION
Earnest, J. E., Jr., Murphy, A. J.
Technical Report 32-1230, October 15, 1968
(Unclassified)

For abstract, see Earnest, J. E., Jr.

Nagler, R. G.

**N01 A LIGHTWEIGHT 6½-ft AEROSHELL FOR
AN EARLY MARS PROBE MISSION**
Nagler, R. G., Boundy, R. A. (Jet Propulsion Laboratory)
Scholl, J. R., Dawson, J. B. (Rohr Corporation)
Technical Report 32-1325, September 15, 1968
(Unclassified)

A lightweight, 6½-ft-diam, sphere-cone, honeycomb-sandwich structure with an elastomeric ablator is described, which is almost an order-of-magnitude lighter per unit area than those in the manned space program, and which allows atmospheric deceleration at densities equivalent to very high altitudes on earth. This structure is made primarily from phenolic fiberglass for ease of fabrication and RF transparency, but titanium rings are used as stiffeners at the outer edge. Details of the fabrication are delineated, and the results of supplementary studies to prove structural reliability and environmental compatibility are given. This type of structure is easily fabricated under normal shop practices; and experience with constructing two of the 6½-ft-diam aeroshells indicates that lightweight, 20-ft-diam (or larger) aeroshells can be fabricated to reasonably close tolerances.

Nash, D. B.

**N02 PROTON BOMBARDMENT-INDUCED TARGET
TEMPERATURES AND THERMAL ACCOMMODATION
COEFFICIENTS OF ROCK POWDERS:
MEASUREMENTS BY INFRARED PYROMETRY**
Nash, D. B.
Technical Memorandum 33-413, February 15, 1969
(Unclassified)

Infrared radiometry is used to measure the surface temperature of rock samples under bombardment by 1–20 keV protons at beam intensities of about 15–100 $\mu A/cm^2$. Temperatures, measured as a function of bombardment time, proton power, rock composition, and target surface geometry, show that powder surfaces heat up rapidly under beams with powers greater than 0.1 W/cm^2 (e.g., 4 keV, 25 $\mu A/cm^2$); loosely packed or fine-grained powders heat up more rapidly and attain higher equilibrium temperatures than tightly packed or coarse-grained powders. Comparative subsurface temperatures obtained with a buried thermocouple show thermocouples to be poor indicators of beam-induced surface temperatures of powders; this results from the low thermal conductivity of powders in vacuum and the consequent steep temperature gradient between the surface and the buried thermocouple. Values for the thermal accommodation (energy transfer) coefficients for 2–16 keV protons incident on basalt powder are calculated from the temperature data and found to range from 0.3 to 0.99, increasing in value with increasing proton energy and target surface temperature.

Nelson, W.

**N03 THE 10-FT SPACE SIMULATOR AT THE
JET PROPULSION LABORATORY**
Alexander, W., Dyckman, L., Harrell, J., Nelson, W.,
Schaefle, W.
Technical Report 32-1231, Revision 1, January 15, 1969
(Unclassified)

For abstract, see Alexander, W.

Newburn, R. L., Jr.

**N04 A BRIEF SURVEY OF THE MAJOR PLANETS: JUPITER,
SATURN, URANUS, AND NEPTUNE**
Newburn, R. L., Jr.
Technical Memorandum 33-424, April 1, 1969
(Unclassified)

A survey is presented of current knowledge about Jupiter, Saturn, Uranus, and Neptune, and their satellites. The best available numerical values are given for physical parameters, including orbital and body properties, atmospheric composition and structure, and photometric parameters. The more acceptable current theories of these bodies are outlined with thorough referencing offering access to the details. This survey attempts to be complete through November 1, 1968.

O'Handley, D. A.

**O01 CARD FORMAT FOR OPTICAL AND RADAR
PLANETARY DATA**
O'Handley, D. A.
Technical Report 32-1296, May 1, 1968
(Unclassified)

The Ephemeris Working Group is an organization of users and producers of optical and radar observations of the moon and planets. Group meetings have provided a useful opportunity for the exchange of ideas on such problems as the analysis and interpretation of observations, the discussion of methods, and the presentation of results. One of the results of the discussions of the Ephemeris Working Group was the desirability of a common format for all observational data in machine-readable form. This report delineates the card formats to be used in the exchange of data.

Oliver, R. E.

**O02 A PARAMETRIC STUDY OF VARIATIONS IN WEIGHT
AND PERFORMANCE CHARACTERISTICS OF
LARGE-AREA SOLAR ARRAYS**
Oliver, R. E., Garba, J. A., Hix, J. H.
Technical Report 32-1337, March 1, 1969
(Unclassified)

A parametric study was made to establish relationships between performance characteristics (power-to-weight ratio, structural resonant frequencies, deflections due to inertia loads, and structural-member stresses) and changes in design

parameters for a large area solar array (LASA) design concept. Variations in design parameters considered in this study include overall geometric scaling of subpanel planform, aspect ratio scaling of subpanel planform, scaling of applied inertial loading, changes in structural material properties, and changes in nonstructural weight.

A computer program was developed to provide results of the parametric study in both tabular and graphical form. The graphical results are presented in a catalogue of plots which can be used to provide "quick look" evaluations of the characteristics to be expected for any new array design which incorporates the basic features of the existing LASA design concept. These plots also illustrate the possible disadvantages (or advantages) associated with alternative (other than beryllium) structural materials.

The parametric study results are not intended as a substitute for a complete and detailed structural analysis which still must be performed for any array to be used in a spaceflight mission. These results can be used, however, as a guide during the preliminary design phase to establish the first estimate of a suitable design to satisfy specified mission requirements.

O'Neil, W. J.

003 THE SURVEYOR III AND SURVEYOR IV FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
O'Neil, W. J., Labrum, R. G., Wong, S. K., Reynolds, G. W.
Technical Report 32-1292, August 15, 1968
(Unclassified)

This report presents the current best estimate of the Surveyor III and the Surveyor IV spacecraft flight paths and describes the way in which they were determined. The effects of inflight and postflight analyses on the tracking data are presented along with the determination of certain physical constants and station locations.

Orlik, F. W.

004 TESTING OF THE SURVEYOR SPACECRAFT AT THE JPL ENVIRONMENTAL TEST LABORATORY
Orlik, F. W.
Technical Report 32-1323, June 1, 1969
(Unclassified)

Most of the Surveyor spacecraft testing was done at the JPL Environmental Test Laboratory (ETL), but facilities at Edwards Air Force Base, California, and Cape Kennedy, Florida, were also used. This report describes the ETL facilities used in the program and the test innovations designed to meet the temperature extremes required in Surveyor environmental testing.

Otoshi, T. Y.

005 THE EFFECT OF MISMATCHED COMPONENTS ON MICROWAVE NOISE-TEMPERATURE CALIBRATIONS
Otoshi, T. Y.
Technical Report 32-1345 (Unclassified)
(Reprinted from IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-16, No. 9, pp. 675–686, September 1968)

A technique is presented for analyzing the effect of mismatched components on the absolute noise-temperature calibrations of principal noise sources in a microwave receiving system. Scattering parameters are used to describe the properties of the microwave network that is connected between noise source and receiver. The calibration method discussed is the Y-factor power-ratio measurement technique involving the use of two thermal noise reference standards.

Calculations made for an operational low-noise antenna receiving system indicate that, even when components have reasonably low-voltage reflection coefficients (typically less than 0.05), peak errors due to mismatches could be as high as 70 and 11% on measured antenna and effective input noise-temperature values, respectively. For the special case where the reflected and direct wave receiver noise sources are fully correlated, the peak errors can be even larger.

Overbey, J. L.

006 COMPUTER-AIDED ANALYSIS OF A PEAK DETECTOR AND ANALOG-TO-PULSE-WIDTH CONVERTER
Overbey, J. L., Locke, J. R.
Technical Memorandum 33-401, March 15, 1969
(Unclassified)

The analysis presented in this report examines a regenerative-type electronic circuit with the use of computer-aided techniques. Novel use of a nonlinear dc circuit analysis program is its application to the problem of studying the triggering point of a Schmitt trigger circuit and its stability as a function of parameter variation. A transient analysis program is used to study the manner in which the triggering point is arrived at for different input waveforms, and the results of both programs are combined to analyze the circuit's overall behavior.

Pace, G.

P01 MARINER VENUS 67 GUIDANCE AND CONTROL SYSTEM
Pace, G.
Technical Report 32-1258, July 1, 1968
(Unclassified)

This report describes the functions of the power, attitude control and central computer and sequencer subsystems, which comprise the Mariner Venus 67 guidance and control system.

Parker, G. L.

P02 **LAUNCH DYNAMIC ENVIRONMENT OF THE *SURVEYOR* SPACECRAFT**
Parker, G. L.
Technical Report 32-1289, September 15, 1968
(Unclassified)

The dynamic environment of the *Surveyor* dynamic models and operational spacecraft during the boost phase of flight is defined. The data acquisition systems and analysis techniques are discussed. Summary flight data from each of nine spacecraft launches for all measured periods of high acoustic energy and random vibration are included. Also included are the transient responses to various pyrotechnic, staging, and jettison events of the boost phase.

Passamaneck, R.

P03 **AERODYNAMIC CHARACTERISTICS OF SPHERICALLY BLUNTED 45-DEG HALF-ANGLE CONES**
Passamaneck, R.
Technical Report 32-1327, September 1, 1968
(Unclassified)

Pressure, force, and dynamic stability tests were conducted to compare theoretically calculated coefficients and pressure distribution to data obtained by experiment. The Newtonian theory has also been included for completeness. Comparisons are made for an ideal gas and a real gas in equilibrium. The dynamic stability test for the real gas was omitted because of tunnel limitations. Pressure distribution was also measured for a real gas in nonequilibrium. The models used were 45-deg cones of bluntness ratios of 0, 0.25, 0.50, 0.75, and 1.00.

Pawlik, E. V.

P04 **SCALING OF A HIGH-PERFORMANCE ION THRUSTER**
Pawlik, E. V.
Technical Memorandum 33-387, July 15, 1968
(Unclassified)

A 20-cm-diam electron-bombardment ion thruster was constructed by scaling a smaller high-performance flight-type unit. The scaling was not exact in that differences existed in the mercury propellant distribution, anode geometry, cathode type, and cathode location. An additional magnetic field also existed due to the spiral configuration of the cathode used. Ion chamber losses equivalent to those presented for the flight-type thruster were obtained.

P05 **POWER MATCHING OF AN ION THRUSTER TO SOLAR CELL POWER OUTPUT**
Pawlik, E. V.
Technical Memorandum 33-392, July 15, 1968
(Unclassified)

A 20-cm-diam thruster was operated over a 2:1 range of output power, allowing for continuous matching of thruster power to a varying solar cell output level. The technique of matching power by varying either the ion beam current or

the net accelerating voltage is described. Ion beam current control, implemented in thruster control loops, utilized existing laboratory hardware. Stable thruster operation was achieved over a range of 1000 to 2000 W. Bistable values of mercury propellant flow at the same discharge chamber and ion beam conditions were also observed.

Perlman, M.

P06 **SPACE APPLICATIONS OF A MINIMIZATION ALGORITHM**
Roth, J. P. (International Business Machines Corporation)
Perlman, M. (Jet Propulsion Laboratory)
Technical Report 32-1385, April 15, 1969
(Unclassified)

For abstract, see Roth, J. P.

Piaggi, E. G.

P07 **THE *RANGER IX* FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA**
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.
Technical Report 32-767, November 1, 1968
(Unclassified)

For abstract, see Vegos, C. J.

Prelewicz, D. A.

P08 **MARINER IV AND V DISTURBANCE TORQUES AND LIMIT CYCLES**
Prelewicz, D. A.
Technical Report 32-1305, October 1, 1968
(Unclassified)

The disturbance torques acting upon the *Mariner IV* and *Mariner V* spacecraft during cruise mode operation are described. The history of the spacecraft rotational motion was obtained by processing sun sensor and Canopus sensor telemetry data, which were used in conjunction with the spacecraft dynamics to obtain qualitative and quantitative disturbance torque characteristics. Interval analysis was used to account for quantization error introduced by the telemetry system. This procedure, together with the assumption of parabolic limit cycles, established definite upper and lower bounds on the disturbance torques at any time.

Data for both *Mariner IV* (Mars 1964) and *Mariner V* (Venus 1967) indicate that low disturbance torques are present for both spacecraft. *Mariner IV* has a comparatively large (between 10 and 30 dyn-cm), slowly varying bias torque (apparently a solar torque) as well as a smaller component which changes by as much as 3–5 dyn-cm when a control valve fires. A small restoring torque ($\sim \frac{1}{4}$ dyn-cm/mrad) in pitch and yaw indicates that the spacecraft is stable about the sun line.

Mariner V is symmetrical about the sun line and hence does not have a large bias solar torque. Since there are no solar vanes, the solar restoring torque is also considerably smaller. However, the disturbance torque, which varies randomly with valve firing (by as much as 2–3 dyn-cm), is present.

P09 MARINER IV AND V DISTURBANCE TORQUES AND LIMIT CYCLES (ADDENDUM)
Prelewicz, D. A.
Technical Report 32-1305, December 15, 1968
(Unclassified)

The procedure used to compute the disturbance torques affecting the *Mariner IV* and *Mariner V* spacecraft during selected periods of flight was explained in JPL Technical Report 32-1305, *Mariner IV and V Disturbance Torques and Limit Cycles*, Oct. 1, 1968. In this Addendum, more extensive examples are given of computer printouts that provide quantitative information on torque limits and limit cycles for the spacecraft. This information is presented in four selected plots of reduced *position data and torque limits vs time* for:

(1) *Mariner IV*, 33⅓ bits/s, days 361–362, 1964.
(2) *Mariner IV*, 33⅓ bits/s, day 366, 1964.
(3) *Mariner IV*, 8⅓ bits/s, days 102–105, 1965.
(4) *Mariner V*, 33⅓ bits/s, days 171–173, 1967.

Prislin, R. H.

P10 ENTRY DYNAMICS OF A SPINNING VEHICLE
Prislin, R. H., Jaffe, P.
Technical Memorandum 33-398, August 15, 1968
(Unclassified)

A closed-form solution for the angular motion of a spinning atmospheric entry vehicle has been developed. The influence and interaction of the density gradient, the spin, the initial angles and angular rates at entry, and the aerodynamics of the vehicle are demonstrated by the solution. The effect of adding spin is to attenuate the influence of the dynamic pressure gradient and to amplify the importance of dynamic stability near, and after, peak deceleration. An important conclusion is that a spinning entry body with zero or small transverse angular velocity will exhibit damped circular motion. In addition, when the motion is nearly circular, the small angle-of-attack restriction implicit in the development of the equation is relaxed, and the region of applicability to high angles of attack is extended. Several examples are presented and comparisons are made with 6-deg-of-freedom calculations of the amplitude history; in all cases, the agreement is better than 5%.

Quade, J.

Q01 AIRBORNE MULTIFREQUENCY MICROWAVE RADIOMETRIC SENSING OF AN EXPOSED VOLCANIC PROVINCE
Blinn, J. C., III (Jet Propulsion Laboratory)
Chapman, P., Quade, J. (University of Nevada)

Technical Memorandum 33-405, October 15, 1968
(Unclassified)

For abstract, see Blinn, J. C., III

Redmann, G. H.

R01 QUALITY ASSURANCE MONITORING OF THE MICROBIOLOGICAL ASPECTS OF THE STERILIZATION ASSEMBLY DEVELOPMENT LABORATORY
Gavin, T. R., Redmann, G. H., Taylor, D. M.
Technical Report 32-1398, May 1, 1969
(Unclassified)

For abstract, see Gavin, T. R.

R02 STERILIZATION ASSEMBLY DEVELOPMENT LABORATORY (SADL) FACILITY DESCRIPTION AND CAPABILITIES
Redmann, G. H.
Technical Report 32-1412, June 15, 1969
(Unclassified)

The Sterilization Assembly Development Laboratory described in this report is the result of a research and development program to evolve the facilities, equipment, and procedures necessary to meet the biological quarantine requirements established by NASA. These requirements minimize the hazard of introducing viable earth organisms to other planets in the solar system via impacting unmanned spacecraft.

Rennilson, J. J.

R03 SURVEYOR III MISSION REPORT PART III. TELEVISION DATA (ADDENDUM)
Rennilson, J. J.
Technical Report 32-1177, July 15, 1968 (Unclassified)

The purpose of this report is to present selected color transparencies from the *Surveyor III* mission. Transparencies were selected rather than color prints because more accurate color control was possible with this process. These color transparencies should be compared with the black and white photographs and descriptions given in Section 3 of NASA Report SP-146, "*Surveyor III*: A Preliminary Report," June 1967.

Renzetti, N. A.

R04 TRACKING AND DATA ACQUISITION REPORT: MARINER MARS 1964 MISSION VOLUME III. EXTENDED MISSION
Renzetti, N. A.
Technical Memorandum 33-239, December 1, 1968
(Unclassified)

This volume summarizes the activities of the Deep Space Network (DSN) during the extended (Phase II) *Mariner* Mars 1964 mission. The period covered is from the end of the original mission in October 1965 until the beginning of the *Mariner* Venus 67 mission in June 1967. The report delineates the tracking, telemetry, and command operations of the DSN and includes equipment configurations at deep space stations.

A log summarizing DSN activity during this period in sequence is provided and includes statistical data relating to time, operating deep-space-station received signal level, and significant events. The DSN technical operations support afforded to the various experiments, investigations, and tests is described, along with the special equipment used by the DSN in its operations.

A summary of the Master Data Library support of Phase I of the *Mariner* Mars 1964 mission and conclusions and interpretations from the solar occultation experiment are included. Much of these efforts were accomplished during the time of Phase II activities and are included for completeness of record.

Reynolds, G. W.

R05 THE *SURVEYOR III* AND *SURVEYOR IV* FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
O'Neil, W. J., Labrum, R. G., Wong, S. K.,
Reynolds, G. W.
Technical Report 32-1292, August 15, 1968
(Unclassified)

For abstract, see O'Neil, W. J.

R06 THE *SURVEYOR V, VI*, AND *VII* FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
Labrum, R. G., Wong, S. K., Reynolds, G. W.
Technical Report 32-1302, December 1, 1968
(Unclassified)

For abstract, see Labrum, R. G.

Rhein, R. A.

R07 PROCESSING SPECTROPHOTOMETRIC MEASUREMENTS TO COMPUTE CHEMICAL REACTION RATES AND CORRELATE THEM TO A RATE EQUATION: A COMPUTER PROGRAM
Rhein, R. A.
Technical Report 32-1384, April 15, 1969
(Unclassified)

Program **RTPROG**, along with subroutine **RATECL** and **MREG**, was designed for processing spectrophotometric transmittance data for the computation of bimolecular initial reaction rates, and the correlation of these rates to expressions of the form of either $Rate = K \cdot C_A^a \cdot C_B^b$, or $Rate = K \cdot C_A^a \cdot C_B^b \cdot e^{-E/RT}$.

Computer output from data processed by this program includes the rate expression coefficients K, a, b (and, where applicable, E), as well as the printout of concentration vs time, the initial reaction rates, and other data in a format that can be readily used for future reference.

This program also directs the printing of detailed instructions to the operator, showing which data are to be fed to the computer and what format is to be followed.

Riebling, R. W.

R08 EXPERIMENTAL EVALUATION OF A THROTTLABLE IMPINGING-SHEET INJECTOR WITH EARTH-STORABLE PROPELLANTS
Riebling, R. W.
Technical Report 32-1330, October 15, 1968
(Confidential)

A multiple-element, unlike-impinging-sheet injector was fired with three earth-storable propellant combinations. Combustion efficiencies were measured during throttling of the injector by two separate techniques: pressure/area-step and discrete-element. During firings, in which the mixture ratio and characteristic chamber length were varied, combustion efficiencies were also measured. Combustion stability and smoothness were monitored; a limited number of chamber and nozzle wall heat-flux measurements were made.

When fired with hydrazine and monomethylhydrazine, maximum density fuming nitric acid appeared competitive with N_2O_4 as to combustion efficiency, stability and smoothness.

Injection elements mounted external to the injector face exhibited rather poor durability, especially during throttling, when the flow of propellants to them was cut off. Installation of the elements within the injector face (a "buried" configuration) might be desirable for future applications.

Riise, H. N.

R09 SOLAR SIMULATOR OPTIMIZATION THROUGH DEFOCUSING: A RESULT OF COMPUTERIZED OPTICAL SYSTEM RAY-TRACING STUDY
Riise, H. N.
Technical Memorandum 33-384, September 15, 1968
(Unclassified)

Collimation and uniformity in the simulated solar beam are the main objects of interest in this analysis. With the simple computer program used, the effect of varying certain parameters — the height of the mixer, the radius of the mixer, and the height of the test plane — could be determined easily. It was found that a theoretical uniformity could be improved from 5.28 to 5.01%, and collimation could be improved from 1.6 to 1.078 deg by defocusing the optical system. The findings were used to locate the mixer most advantageously during its installation in the JPL 25-ft space simulator solar system.

Rindfleisch, T.

R10 LUNAR EXPLORATION: THE IMPACT OF *RANGER* AND *SURVEYOR* RESULTS
Stewart, H. J., Hibbs, A. R., Conel, J. E., Rindfleisch, T.
Technical Report 32-1399 (Unclassified)
(Reprinted from *Astronautics and Aeronautics*, Vol. 7, No. 1, January 1969)

For abstract, see Stewart, H. J.

Ritchie, D. W.

R11 SKY EFFECT ON SOLAR CELLS CALIBRATED AT 80,000 FEET
Ritchie, D. W.
Technical Report 32-1313, October 15, 1968
(Unclassified)

The use of high-altitude balloon flights for the calibration of standard solar cells has been proven to be a reliable method of obtaining space-calibrated solar cells for terrestrial and laboratory measurements. A technique is presented to help further refine these methods by determining the percentage of sky radiation incident on solar cells during the balloon cell calibration. It was found that the contributions of sky radiation to the output of solar cells at 80,000 feet were less than 0.5%.

Rogero, R. S.

R12 AN EXPERIMENTAL DESCRIPTION OF DESTRUCTIVE LIQUID ROCKET RESONANT COMBUSTION
Clayton, R. M., Rogero, R. S., Sotter, J. G.
Technical Report 32-1293 (Unclassified)
(Reprinted from AIAA, Vol.6, No. 7, July 1968, pp. 1252–1259)

For abstract, see Clayton, R. M.

Roth, J. P.

R13 SPACE APPLICATIONS OF A MINIMIZATION ALGORITHM
Roth, J. P. (International Business Machines Corporation)
Perlman, M. (Jet Propulsion Laboratory)
Technical Report 32-1385, April 15, 1969
(Unclassified)

This report details the applications of an IBM 7094 minimization program to several design problems at the Jet Propulsion Laboratory. Specifically, these applications are concerned with the design of a curve function generator for a mass spectrometer for a proposed Mars probe, and the design of autonomous shift registers with linear and nonlinear feedback, used for the classification of binary sequences and counting tasks for spacecraft scientific data processing. A description of the algorithm and the program used is followed by a description of the applications.

Rouklove, P.

R14 PARAMETRIC TESTS OF THERMOELECTRIC GENERATOR SNAP-11
Rouklove, P.
Technical Report 32-1294, September 1, 1968
(Confidential)

Abstract is classified.

Rupe, J. H.

R15 AN EXPERIMENTAL CORRELATION OF THE NONREACTIVE PROPERTIES OF INJECTION SCHEMES AND COMBUSTION EFFECTS IN A LIQUID-PROPELLANT ROCKET ENGINE: PART V. ON THE INFLUENCE OF VANES ON COMBUSTION AND COMBUSTION STABILITY
Rupe, J. H.
Technical Report 32-255, September 15, 1967
(Unclassified)

Experimental observations of a high-amplitude resonant wave characteristic of several liquid-propellant rocket engine configurations are presented. These observations led to the postulate that the disturbance is a detonation-like wave that is not dependent upon the acoustic properties of the cavity for either initiation or sustenance and a consequential conclusion that the nonlinear properties of such processes must be understood as a first step in controlling this combustion mode. Results of a cursory evaluation of the control introduced by baffles (or vanes) and the heat-transfer rates imposed on the chamber walls for the resonant mode as compared to steady combustion are included.

Sanger, D. K.

S01 DIGITAL DEMODULATION WITH DATA SUBCARRIER TRACKING
Sanger, D. K.
Technical Report 32-1314, August 1, 1968
(Unclassified)

The concept of digital telemetry demodulation depends upon a computer algorithm to accomplish bit synchronization by testing the incoming data stream over intervals that are one-third of a bit time early and one-third of a bit time late with respect to the estimated data transition time. Correct bit synchronization results when the estimated timing intervals have been adjusted properly. This early–late bit timing scheme coupled with a Costas data tracking loop is the basis for the digital demodulator discussed in this report.

Schaefle, W.

S02 THE 10-FT SPACE SIMULATOR AT THE JET PROPULSION LABORATORY
Alexander, W., Dyckman, L., Harrell, J., Nelson, W., Schaefle, W.
Technical Report 32-1231, Revision 1, January 15, 1969
(Unclassified)

For abstract, see Alexander, W.

Scholl, J. R.

S03 A LIGHTWEIGHT 6½-ft AEROSHELL FOR AN EARLY MARS PROBE MISSION
Nagler, R. G., Boundy, R. A. (Jet Propulsion Laboratory)
Scholl, J. R., Dawson, J. B. (Rohr Corporation)

Technical Report 32-1325, September 15, 1968
(Unclassified)

For abstract, see Nagler, R. G.

Selzer, R. H.

S04 IMPROVING BIOMEDICAL IMAGE QUALITY WITH COMPUTERS
Selzer, R. H.
Technical Report 32-1336, October 1, 1968
(Unclassified)

The analysis of pictorial data in the biomedical fields has increased sufficiently in the past few years to warrant the use of computers to process this data. A description of image processing research conducted at JPL, particularly in the area of image enhancement, is contained in this paper. Frequency-response methods, which allow computer processing techniques to be directly related to the imaging system and to the image subject, are discussed. The most important enhancement technique, two-dimensional digital filtering, is described and illustrated with numerical examples. Examples of before-and-after computer-processed pictures are shown which illustrate low-pass, high-pass, high-frequency restoration, feature-selective and nonlinear filters. Subtraction techniques are also discussed and an example is given of a computerized film-measurement procedure that requires preprocessing of the image by filtering techniques. This application involves measurement of the width of trabecular bone shadows from X-ray film.

Semtner, A. J.

S05 POLYNOMIAL SMOOTHING FORMULAS AND DERIVATIVE FORMULAS FOR ONE OR TWO INDEPENDENT VARIABLES
Semtner, A. J.
Technical Report 32-1312, November 15, 1968
(Unclassified)

A systematic procedure is described for the determination of coefficients in linear smoothing formulas and related derivative estimation formulas, and coefficients are tabulated for a selection of commonly useful formulas of this type.

Sherry, E. J.

S06 A PRELIMINARY QUARANTINE ANALYSIS OF A POSSIBLE MARINER VENUS 1972 MISSION
Craven, C. W., Sherry, E. J., Stern, J. A.
Technical Memorandum 33-377, April 15, 1968
(Unclassified)

For abstract, see Craven, C. W.

Shinozuka, M.

S07 ON THE BOUND OF FIRST EXCURSION PROBABILITY
Yang, J. N., Shinozuka, M.
Technical Report 32-1304, August 15, 1968 (Unclassified)

For abstract, see Yang, J. N.

S08 A NOTE ON THE FIRST PASSAGE TIME PROBLEM
Yang, J. N., Shinozuka, M.
Technical Report 32-1334, October 15, 1968
(Unclassified)

For abstract, see Yang, J. N.

Shipley, J. W.

S09 ANALYSIS OF PROBLEMS RELATED TO SLINGSHOT SHOCK MACHINE HIGH-VELOCITY SHOCK TESTING
Shipley, J. W.
Technical Report 32-1342, June 15, 1969
(Unclassified)

This report describes an engineering analysis of a slingshot shock machine to make it suitable for conducting qualification tests on spacecraft hardware. The primary objectives of the analysis were to:

(1) Specify the setup for a given test, particularly in the area of acceleration level and pulse duration.

(2) Indicate possible modifications to the machine.

(3) Improve the techniques of making motion measurements.

Shlichta, P. J.

S10 A CONTACT RULE FOR RIGID-SPHERE MODELS OF CRYSTAL STRUCTURES
Shlichta, P. J.
Technical Report 32-1299, August 1, 1968
(Unclassified)

If a crystal structure is regarded as a space-group array of rigid spheres in contact, then the relationship $F = P - C + 1$ holds, where P is the number of dimensionless variable parameters of the structure and F is the number of degrees of freedom in parameter-space when C modes of contact are present. This contact rule is, like Gibbs' phase rule, a simultaneous-equation rule and permits the construction of contact diagrams that show how atomic contacts change as the structural parameters are varied. These diagrams provide a convenient means of calculating and displaying the parametric variation of such properties as connectivity, coordination number, packing fraction, and the Madelung constant. To the extent that atomic radii and bond type are physically meaningful concepts, the contact rule is also useful for optimizing atomic position parameters in trial structures, comparing the bonding properties of different structures, deriving consistent values for atomic radii, and characterizing bond type.

Shulman, G. P.

S11 ORGANIC ANALYSIS BY PYROLYSIS-GAS CHROMATOGRAPHY-MASS SPECTROMETRY: A CANDIDATE EXPERIMENT FOR THE BIOLOGICAL EXPLORATION OF MARS
Simmonds, P. G., Shulman, G. P., Stembridge, C. H.
Technical Report 32-1368 (Unclassified)

(Reprinted from *Journal of Gas Chromatography*, Vol. 7, pp. 36–41, January 1969)

For abstract, see Simmonds, P. G.

Silver, R. H.

S12 STUDIES ON ETHYLENE OXIDE—FREON 12 DECONTAMINATION AND DRY-HEAT STERILIZATION CYCLES

Kalfayan, S. H., Silver, R. H., Campbell, B. A.
Technical Report 32-1310, August 15, 1968
(Unclassified)

For abstract, see Kalfayan, S. H.

Simmonds, P. G.

S13 ORGANIC ANALYSIS BY PYROLYSIS-GAS CHROMATOGRAPHY-MASS SPECTROMETRY: A CANDIDATE EXPERIMENT FOR THE BIOLOGICAL EXPLORATION OF MARS

Simmonds, P. G., Shulman, G. P., Stembridge, C. H.
Technical Report 32-1368 (Unclassified)
(Reprinted from *Journal of Gas Chromatography*, Vol. 7, pp. 36–41, January 1969)

One of the experiments suggested for an early Mars lander involves the organic analysis of Martian soil by an automated pyrolysis-gas chromatography-mass spectrometry system. Studies to test the feasibility of this technique for the bio-organic analysis of soil have recently been performed. Comparative analyses of desert soils, Precambrian shales, and meteorites have been undertaken to demonstrate the ability of the method to distinguish material of present biological origin from fossil or meteoritic organic matter.

Sjogren, W. L.

S14 GRAVITATIONAL INCONSISTENCY IN THE LUNAR THEORY: CONFIRMATION BY RADIO TRACKING

Cary, C. N., Sjogren, W. L.
Technical Report 32-1290, Part II (Unclassified)
(Reprinted from *Science*, Vol. 160, May 24, 1968, pp. 875–876)

For abstract, see Cary, C. N.

S15 CONSTANTS AND RELATED INFORMATION FOR ASTRODYNAMIC CALCULATIONS, 1968

Melbourne, W. G., Mulholland, J. D.
Sjogren, W. L., Sturms, F. M., Jr.
Technical Report 32-1306, July 15, 1968
(Unclassified)

For abstract, see Melbourne, W. G.

S16 CONSISTENCY OF *LUNAR ORBITER* RESIDUALS WITH TRAJECTORY AND LOCAL GRAVITY EFFECTS

Muller, P. M., Sjogren, W. L.
Technical Report 32-1307, September 1, 1968
(Unclassified)

For abstract, see Muller, P. M.

S17 MASCONS: LUNAR MASS CONCENTRATIONS

Muller, P. M., Sjogren, W. L.
Technical Report 32-1339 (Unclassified)
(Reprinted from *Science, Vol 161, No. 3842*, pp. 680–684, August 16, 1968)

For abstract, see Muller, P. M.

Sloan, R. K.

S18 *MARINER* MARS 1964 PROJECT REPORT: SCIENTIFIC EXPERIMENTS

Sloan, R. K.
Technical Report 32-883, July 15, 1968
(Unclassified)

Discussions are presented for each of the six instruments and the measurements obtained from the fields and particles experiments of the *Mariner* Mars 1964 mission. The majority of the instruments performed well and all provided useful measurements enhancing the information on interplanetary space and on the near-earth and near-Mars environments. Specifically, the six instruments on the *Mariner IV* spacecraft measured:

(1) Trapped radiation detector — electron and proton radiation belts at earth and Mars and particle phenomena in interplanetary space.

(2) Cosmic dust detector — mass and flux distribution of interplanetary dust particles.

(3) Ionization chamber — average total ionization of high-energy particle radiation.

(4) Cosmic ray telescope — spectral energy analysis of high-energy cosmic and solar protons and α particles including directional variations.

(5) Helium magnetometer — magnitude and direction of planetary and interplanetary magnetic fields.

(6) Plasma probe — density, velocity, and direction of charged particles making up the solar wind.

Also discussed is the radio frequency occultation experiment that used the spacecraft radio signal passage through the Martian atmosphere to determine characteristics of its atmosphere, specifically the density and intensity of the ionosphere, surface pressure, and scale height of the lower atmosphere.

Smokler, M. I.

S19 SURVEYOR V MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1246, July 15, 1968
(Unclassified)

For abstract, see Bird, T. H.

S20 SURVEYOR VI MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1262, August 15, 1968
(Unclassified)

For abstract, see Bird, T. H.

S21 SURVEYOR VII MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1264, September 1, 1968
(Unclassified)

For abstract, see Bird, T. H.

S22 THE SURVEYOR TELEVISION CAMERA AS A SCIENTIFIC INSTRUMENT
Smokler, M. I.
Technical Report 32-1374 (Unclassified)
(Reprinted from Proceedings of the Society of Photo-optical Instrumentation Engineers 13th Annual Technical Symposium, Washington, D.C., August 19–23, 1968)

The Surveyor television camera was converted from an essentially qualitative viewing device into a quantitative measuring instrument by a rigorous calibration program coupled with a sophisticated data processing program. The processing program introduced compensation for the television system response to correct photometry, geometric linearity, and resolution. The output data in the form of both numeric printout records and photographs could then be used to determine optical and other physical properties of the lunar environment.

Smyth, D. L.

S23 SURVEYOR V MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1246, July 15, 1968
(Unclassified)

For abstract, see Bird, T. H.

S24 SURVEYOR VI MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1262, August 15, 1968
(Unclassified)

For abstract, see Bird, T. H.

S25 SURVEYOR VII MISSION REPORT PART III. TELEVISION DATA
Bird, T. H., Smokler, M. I., Smyth, D. L.
Technical Report 32-1264, September 1, 1968
(Unclassified)

For abstract, see Bird, T. H.

Sotter, J. G.

S26 AN EXPERIMENTAL DESCRIPTION OF DESTRUCTIVE LIQUID ROCKET RESONANT COMBUSTION
Clayton, R. M., Rogero, R. S., Sotter, J. G.
Technical Report 32-1293 (Unclassified)
(Reprinted from AIAA, Vol. 6, No. 7, July 1968, pp. 1252–1259)

For abstract, see Clayton, R. M.

Spear, A. J.

S27 A HIGH-RATE TELEMETRY SYSTEM FOR THE MARINER MARS 1969 MISSION
Tausworthe, R. C., Easterling, M. F., Spear, A. J.
Technical Report 32-1354, April 1, 1969
(Unclassified)

For abstract, see Tausworthe, R. C.

Stelzried, C. T.

S28 THE ULTRA CONE: AN ULTRA-LOW-NOISE SPACE COMMUNICATION GROUND RADIO-FREQUENCY SYSTEM
Levy, G. S., Bathker, D. A., Higa, W., Stelzried, C. T.
Technical Report 32-1340 (Unclassified)
(Reprinted from IEEE Transactions on Microwave Theory and Techniques, Vol. MTT-16, No. 9, pp. 596–602, September 1968)

For abstract, see Levy, G. S.

Stembridge, C. H.

S29 ORGANIC ANALYSIS BY PYROLYSIS-GAS CHROMATOGRAPHY-MASS SPECTROMETRY: A CANDIDATE EXPERIMENT FOR THE BIOLOGICAL EXPLORATION OF MARS
Simmonds, P. G., Shulman, G. P., Stembridge, C. H.
Technical Report 32-1368 (Unclassified)
(Reprinted from Journal of Gas Chromatography, Vol. 7, pp. 36–41, January 1969)

For abstract, see Simmonds, P. G.

Stern, J. A.

S30 PLANETARY QUARANTINE AND SPACE VEHICLE STERILIZATION
Craven, C. W., Stern, J. A., Ervin, G. F.
Technical Report 32-1276 (Unclassified)
(Reprinted from *Astronautics & Aeronautics,*
Vol. 6, No. 8, pp. 18–48, August 1968)

For abstract, see Craven, C. W.

S31 A PRELIMINARY QUARANTINE ANALYSIS OF A POSSIBLE *MARINER* VENUS 1972 MISSION
Craven, C. W., Sherry, E. J., Stern, J. A.
Technical Memorandum 33-377, April 15, 1968
(Unclassified)

For abstract, see Craven, C. W.

Stewart, H. J.

S32 LUNAR EXPLORATION: THE IMPACT OF *RANGER* AND *SURVEYOR* RESULTS
Stewart, H. J., Hibbs, A. R., Conel, J. E., Rindfleisch, T.
Technical Report 32-1399 (Unclassified)
(Reprinted from *Astronautics and Aeronautics,* Vol. 7,
No. 1, January 1969)

This report is a compilation of the following articles dealing with the *Ranger* and *Surveyor* probes and their results: Lunar Exploration — The First Decade Raises More Questions Than It Answers; *Surveyor* Results; What the *Rangers* Revealed About Lunar Geology; and Getting More Out of *Ranger* Pictures by Computer.

Strand, L. D.

S33 A COMPARISON OF TWO METHODS OF MEASURING PARTICLE SIZE OF Al₂O₃ PRODUCED BY A SMALL ROCKET MOTOR
Dobbins, R. A. (Brown University)
Strand, L. D. (Jet Propulsion Laboratory)
Technical Report 32-1383, June 1, 1969
(Unclassified)

For abstract, see Dobbins, R. A.

Sturms, F. M., Jr.

S34 CONSTANTS AND RELATED INFORMATION FOR ASTRODYNAMIC CALCULATIONS, 1968
Melbourne, W. G., Mulholland, J. D.
Sjogren, W. L., Sturms, F. M., Jr.
Technical Report 32-1306, July 15, 1968
(Unclassified)

For abstract, see Melbourne, W. G.

Surveyor Project

S35 *SURVEYOR III* MISSON REPORT: PART III. TELEVISION DATA
Surveyor Project
Technical Report 32-1177, November 10, 1967
(Unclassified)

Part I of this report consists of a technical description and an evaluation of engineering results of the systems used in the *Surveyor III* mission. Part II presents the scientific data derived from the mission, and the scientific analyses conducted by the *Surveyor* Scientific Evaluation Advisory Team, the *Surveyor* investigator teams, and the associated working groups. Part III presents 232 individual television pictures, as well as some mosaics composed of individual frames; appropriate information for interpreting these pictures is given.

S36 *SURVEYOR VI* MISSION REPORT: PART I. MISSION DESCRIPTION AND PERFORMANCE
Surveyor Project
Technical Report 32-1262, September 15, 1968
(Unclassified)

This three-part document constitutes the project mission report on *Surveyor VI*, the sixth in a series of unmanned missions designed to soft-land on the moon and return data from the lunar surface. Part I was compiled using contributions of many individuals in the major systems that supported the project, and is based on data evaluation prior to approximately January 1, 1968. Some of the information in this report was obtained from other published documents; a list of these documents is presented in a bibliography.

S37 *SURVEYOR VII* MISSION REPORT: PART I. MISSION DESCRIPTION AND PERFORMANCE
Surveyor Project
Technical Report 32-1264, February 15, 1969
(Unclassified)

Surveyor VII, the last in a series of seven unmanned spacecraft designed to soft-land on the moon and return engineering and scientific data, was launched from Cape Kennedy, Florida, on January 7, 1968. The spacecraft touched down on the ejecta or flow blanket north of the crater Tycho in the lunar highlands at 40.92°S latitude and 11.45°W longitude. *Surveyor VII* performed extensive operations and experiments on the first lunar day and also was operated for a considerable period of time during the second lunar day. A large quantity of high-quality television pictures were obtained from the rock-strewn surface on which the spacecraft landed. In addition, other new information was obtained, including data on the chemical composition of the lunar surface from operation of an alpha scattering instrument and data on the physical properties of the lunar surface from operation of a soil mechanics/surface sampler. This was the first mission on which both these instruments were carried.

The surface sampler was used to overcome a problem with deployment of the alpha scattering instrument and also to redeploy it on the lunar surface.

S38 SURVEYOR VII MISSION REPORT: PART II. SCIENCE RESULTS
Surveyor Project
Technical Report 32-1264, March 15, 1968
(Unclassified)

This three-part document constitutes the project mission report on Surveyor VII, the last spacecraft in a series of unmanned lunar soft-landing missions.

Part II includes the scientific analyses conducted by the Surveyor scientific evaluation advisory team, the Surveyor investigator teams, and the associated working groups. Results are based on data evaluation prior to March 15, 1968. It is expected that future evaluation and analysis of the Surveyor VII data will provide additional science results.

S39 SURVEYOR PROJECT FINAL REPORT: PART I. PROJECT DESCRIPTION AND PERFORMANCE, VOLUMES I AND II
Surveyor Project
Technical Report 32-1265, July 1, 1969
(Unclassified)

The Surveyor Project planned and conducted seven unmanned lunar missions for which spacecraft were launched between May 1966 and January 1968 to provide data in support of the Apollo Programs. Surveyor was a fully attitude-stabilized spacecraft designed to receive and execute a wide variety of earth commands, as well as to perform certain automatic functions including the critical terminal-descent and soft-landing sequences. Significant new and advanced subsystems that were developed and/or used in combination to enable Surveyor to execute the complex terminal phase of flight were: (1) a solid-propellant main retro motor, (2) throttlable liquid-propellant vernier engines (also used for midcourse velocity correction), (3) highly sensitive velocity- and altitude-sensing radars, and (4) an automatic closed-loop guidance and control system.

The first Surveyor spacecraft carried a survey television camera which, together with other engineering instrumentation, obtained in-flight and post-landing data. The complement of instruments carried on later missions included various combinations of the following additional devices: (1) a soil mechanics/surface sampler instrument for picking, digging, and handling lunar surface material; (2) an alpha scattering instrument for performing a chemical analysis of the lunar surface material; and (3) magnets attached to the spacecraft for determining magnetic properties of the soil.

S40 SURVEYOR PROJECT FINAL REPORT: PART II. SCIENCE RESULTS
Surveyor Project
Technical Report 32-1265, June 15, 1969
(Unclassified)

This two-part document constitutes the final project report on the Surveyor spacecraft. Part I of this report consisted of a technical description and an evaluation of engineering results of the systems used on Surveyor. Part II presents the science data derived from the lunar soft-landing missions, and the scientific analyses conducted by the Surveyor Scientific Evaluation Advisory Team, the Surveyor Investigator Teams, and the associated Working Groups.

Results given in this part of report are based on data evaluation before June 15, 1968. It is expected that future evaluations and analyses will provide additional science results.

Tausworthe, R. C.

T01 A HIGH-RATE TELEMETRY SYSTEM FOR THE MARINER MARS 1969 MISSION
Tausworthe, R. C., Easterling, M. F., Spear, A. J.
Technical Report 32-1354, April 1, 1969
(Unclassified)

A multi-mission, deep-space, high-rate telemetry system has been developed for the Mariner Mars 1969 mission. Its rationale, analysis, and development into hardware are described, along with its subsequent planned application to an actual spacecraft mission, whose preparation is in progress. The spacecraft system encodes raw binary data into a comma-free, biorthogonal code that antipodally modulates a square-wave subcarrier. In turn, this subcarrier phase-modulates the downlink carrier. Separate signals are not required for subcarrier, word, or symbol sync; thus all transmitted sideband power is available for data transmission. System design and actual data are presented. These data were taken at several levels of system design and functional verification, including some of the spacecraft performance tests.

Taylor, D. M.

T02 QUALITY ASSURANCE MONITORING OF THE MICROBIOLOGICAL ASPECTS OF THE STERILIZATION ASSEMBLY DEVELOPMENT LABORATORY
Gavin, T. R., Redmann, G. H., Taylor, D. M.
Technical Report 32-1398, May 1, 1969
(Unclassified)

For abstract, see Gavin, T. R.

Thornton, T. H., Jr.

T03 THE SURVEYOR I AND SURVEYOR II FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
Thornton, T. H., Jr., et al.
Technical Report 32-1285, August 1, 1968 (Unclassified)

This report describes the current best estimate of the *Surveyor I* and *Surveyor II* flight paths and the way in which they were determined. The function and organization of the flight path analysis and command group — by whom the flight path and the midcourse and terminal-descent maneuvers were determined in real time — are described. Detailed accounts are given for each phase of the flights. Data summaries and analyses include: (1) the orbit determination process and the best estimates of the pre-midcourse correction orbit and the post-midcourse correction orbit; (2) the postflight analysis of the transponder tracking data to give the final best estimates of the pre- and postmaneuver orbits, as well as the estimated values for station locations and certain physical constants; (3) the scheme used for determining the midcourse correction and the terminal maneuver; (4) pertinent trajectory characteristics; (5) and the inflight and postflight analysis of the Air Force Eastern Test Range tracking data.

Trask, D. W.

T04 THE *RANGER IX* FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.
Technical Report 32-767, November 1, 1968
(Unclassified)

For abstract, see Vegos, C. J.

Trubert, M. R.

T05 AN ANALOG TECHNIQUE FOR THE EQUALIZATION OF MULTIPLE ELECTROMAGNETIC SHAKERS FOR VIBRATION TESTING
Trubert, M. R.
Technical Report 32-1364 (Unclassified)
(Reprinted from *Journal of Spacecraft and Rockets,*
Vol. 5, No. 12, pp. 1438–1443, December 1968)

A method that uses an analog computer to perform an open-loop control (equalization) for multishaker environmental vibration testing is presented. The computer is programmed to simulate the equations of motion of the electromechanical system. The input to the computer is an electrical signal representing the acceleration time histories to be reproduced at the base of the structure. Examples of multishaker equalization are shown for transient testing and random testing on a beam excited at two points. The method is valid for random, transient, and harmonic vibration testing.

T06 ANALYSIS OF SPACE VEHICLE STRUCTURES USING THE TRANSFER-FUNCTION CONCEPT
Heer, E., Trubert, M. R.
Technical Report 32-1367, April 1, 1969
(Unclassified)

For abstract, see Heer, E.

T07 MEASUREMENT OF STRUCTURAL TRANSFER FUNCTIONS SIGNIFICANT TO FLIGHT STABILITY OF THE *SURVEYOR* SPACECRAFT
Gayman, W. H., Trubert, M. R. (Jet Propulsion Laboratory)
Abbott, P. W. (General Dynamics Corporation)
Technical Memorandum 33-389, May 1, 1969
(Unclassified)

For abstract, see Gayman, W. H.

Truscello, V.

T08 POWER SYSTEM DESIGN FOR JUPITER SOLAR ELECTRIC PROPULSION SPACECRAFT
Truscello, V. (Jet Propulsion Laboratory)
Loucks, R. E. (TRW Systems)
Technical Report 32-1347, October 15, 1968
(Unclassified)

The design of an electrical power system for a solar electric spacecraft mission to Jupiter is described. The system includes a large-area photovoltaic solar array for primary electrical power, a "hibernating" AgZn battery subsystem for energy storage, and power conditioning equipment for conversion and distribution of power to spacecraft loads. The system combines a programmed ion engine power consumption profile with a solar panel maximum power point tracker for ion engine control and load matching. This combination minimizes the problem of predicting the solar-panel output power available for ion engine consumption as a function of mission time. The study includes an evaluation of the effects of proton, electron, and micrometeoroid damage on the performance of the solar array.

Vango, S. P.

V01 IMPROVED SAMPLING AND ANALYTICAL PROCEDURE FOR NITROGEN TETROXIDE AND MIXED OXIDES OF NITROGEN
Vango, S. P.
Technical Report 32-1282, October 15, 1968
(Unclassified)

A scheme is presented for sampling and analyzing nitrogen tetroxide and the mixed oxides of nitrogen. The improved procedure provides meaningful samples of these hydroscopic and volatile materials, and the analytical procedure eliminates an inherent error in the military procedures when carbon dioxide is present as a dissolved impurity. Some other modifications in the military procedure are also described.

Vegos, C. J.

V02 THE *RANGER IX* FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.

Technical Report 32-767, November 1, 1968
(Unclassified)

This report describes the current best estimate of the *Ranger IX* spacecraft flight path and the method used to analyze the tracking data. Deep Space Instrumentation Facility tracking of the spacecraft was virtually continuous from injection to lunar impact. TV photos of the lunar surface were received at the Goldstone Deep Space Communication Station during the last 18 min before impacting the moon. The lunar surface that was photographed was the area of the crater Alphonsus. Postflight analysis of the tracking data resulted in valuable determination of the masses of the earth and the moon, tracking station locations, lunar ephemeris scale factor, and lunar radius of the *Ranger IX* on the surface of the moon is known to within 0.5 km.

Wallace, R. A.

W01 THE *RANGER IX* FLIGHT PATH AND ITS DETERMINATION FROM TRACKING DATA
Vegos, C. J., Borncamp, F., Liu, A. S.
Piaggi, E. G., Trask, D. W., Wallace, R. A.
Technical Report 32-767, November 1, 1968
(Unclassified)

For abstract, see Vegos, C. J.

Weaver, L. E.

W02 A CONTROL SYSTEM STUDY FOR AN IN-CORE THERMIONIC REACTOR
Weaver, L. E., Gronroos, H. G., Guppy, J. G., Davis, J. P.
Technical Report 32-1355, January 15, 1969
(Unclassified)

Conceptual reactor controllers for in-core thermionic reactor space powerplants have been investigated by analysis and by analog simulation. The control system was specified to maintain constant output voltage at the reactor terminals, while minimizing the effect of electric load changes and internal and external disturbances.

Using state-variable feedback design techniques and linearized system equations, constant feedback coefficients were determined so as to give the desired system response. The sensitivity to parameter variations and noise was evaluated. The controller design obtained by analysis of the linear model was applied to the corresponding nonlinear model simulated on analog computers. The correlation between the results predicted with the linear model and those obtained by the simulation was found to be good.

These investigations were exploratory; however, it appears that an in-core thermionic reactor can be controlled by relatively simple means. Loss of controller feedback elements does not cause stability problems if the control signal is constrained. All results were obtained for constant-temperature current–voltage characteristics for the thermionic diodes that do not cross each other in the range of operating conditions.

Weaver, R. W.

W03 ESTIMATES OF THE AERODYNAMIC FORCES AND MOMENTS ACTING ON PARABOLIC ANTENNAS IN THE MARTIAN SURFACE ATMOSPHERE
Weaver, R. W.
Technical Memorandum 33-394, May 15, 1969
(Unclassified)

Study results are based on existing data that were obtained in other experiments. The results are, therefore, estimates, but are judged to be representative of the true case. Shape and porosity effects are discussed as well as Reynolds number significance.

Weston, C. R.

W04 A MATHEMATICAL MODEL OF THE EFFECT OF A PREDATOR ON SPECIES DIVERSITY
Yang, J. N., Weston, C. R.
Technical Report 32-1359, June 15, 1969
(Unclassified)

For abstract, see Yang, J. N.

Williams, A. N.

W05 VARIATIONS IN LAUNCH VEHICLE PERFORMANCE FROM A MISSION PLANNING VIEWPOINT
Williams, A. N.
Technical Memorandum 33-400, September 1, 1968
(Unclassified)

Launch vehicle performance is discussed from the user's point of view and with respect to payload determination in early phases of spacecraft design and mission planning. The emphasis is on the differences between (1) performance guaranteed for a specific, well-identified mission, and (2) performance estimated on a general basis before the mission has been studied in depth by the cognizant agencies. Checklists of requirements are presented to aid in reviewing preliminary launch vehicle weight and performance data. These can assist in recognizing the factors that affect the weight of spacecraft support hardware and mission-peculiar jettison weight of the injection stage.

Willson, R. C.

W06 EXPERIMENTAL AND THEORETICAL COMPARISON OF THE JPL ACTIVE CAVITY RADIOMETRIC SCALE AND THE INTERNATIONAL PYRHELIOMETRIC SCALE
Willson, R. C.
Technical Report 32-1365, February 1, 1969
(Unclassified)

The active cavity radiometer, a new and accurate standard detector, has been developed for the absolute measurement of optical radiant flux. The active cavity radiometric scale, defined by the active cavity radiometer, and the international pyrheliometric scale, defined by the angstrom pyrheliometer,

have been compared in a recent experiment. Simultaneous measurements of solar irradiance demonstrated an average systematic difference between the two scales of 2.2% with the measurements on the active cavity radiometric scale exceeding those on the international pyrheliometric scale. An analytical study of the sensitivities of both the active cavity radiometer and the angstrom pyrheliometer to common sources of experimental error is presented. The theoretical uncertainty in the active cavity radiometric scale is found to be ±0.4%, and that of the international pyrheliometric scale ±2.6% relative to a scale based upon fundamental thermodynamic principles. Application of the average +2.2% difference between the two scales to the result of a recent extra-atmospheric solar constant measurement reported on the international pyrheliometric scale yields a solar constant value of $Ho = 139.1$ mW/cm². A recent high-altitude measurement of the solar constant and spectral distribution made by two active cavity radiometers yielded $Ho = 139.0$ mW/cm².

Wong, S. K.

W07 THE SURVEYOR III AND SURVEYOR IV FLIGHT PATHS AND THEIR DETERMINATION FROM TRACKING DATA
O'Neil, W. J., Labrum, R. G., Wong, S. K.,
Reynolds, G. W.
Technical Report 32-1292, August 15, 1968
(Unclassified)

For abstract, see O'Neil, W. J.

W08 THE SURVEYOR V, VI, AND VII FLIGHT PATHS AND THEIR DETERMINATION FROM DATA
Labrum, R. G., Wong, S. K., Reynolds, G. W.
Technical Report 32-1302, December 1, 1968
(Unclassified)

For abstract, see Labrum, R. G.

Woo, R.

W09 MULTIPACTING DISCHARGES BETWEEN COAXIAL ELECTRODES
Woo, R.
Technical Report 32-1256 (Unclassified)
(Reprinted from Journal of Applied Physics, Vol. 39,
No. 3, February 15, 1968, pp. 1528–1533)

Experimental evidence is presented to demonstrate the scaling relations of the similarity principle for multipacting as applied to coaxial electrodes with b/a (b and a are the radii of the outer and inner electrodes, respectively) varying between 2.3 and 18.26. The two field configurations considered are: (1) RF voltage applied to the electrodes and (2) RF and dc voltages applied to the electrodes. The modes of multipacting are also studied and identified.

W10 RF VOLTAGE BREAKDOWN IN COAXIAL TRANSMISSION LINES
Woo, R.
Technical Report 32-1379 (Unclassified)
(Reprinted from the Proceedings of the IEEE, Vol. 57,
No. 2, pp. 254–256, February 1969)

Data have been obtained for RF voltage breakdown in air for the 50-Ω coaxial transmission line configuration and are presented in a unified, concise, and practical plot.

Wright, F. H.

W11 FAILURE RATE ANALYSIS OF MARINER VENUS 67 SPACECRAFT DATA
Wright, F. H.
Technical Report 32-1266, June 1, 1969
(Unclassified)

This report describes an analysis of spacecraft part-hours and failure data from the Mariner Venus 67 Project. It contains failure rates by generic class for all the electronic and electromagnetic parts on the Mariner V spacecraft. Also included is an updated summary of Mariner Mars 1964 Project failure/part-hour data.

Wu, C.-S.

W12 A UNIFIED QUASILINEAR THEORY OF WEAKLY TURBULENT PLASMAS
Wu, C.-S.
Technical Memorandum 33-397, August 1, 1968
(Unclassified)

A quasilinear theory is formulated that includes the microscopic fluctuation fields as well as the coherent waves. The study emphasizes those cases in which the propagating mode of the fluctuation field gives rise to a dominant contribution to the particle correlation. In other words, in these cases the spontaneous Cerenkov emission of plasmons can play a more important role than the two-particle collision process. The instability that is responsible for the turbulence can be of either electrostatic or electromagnetic, or of mixed nature. The effect of an external magnetic field is also considered in the present theory. The final result is valid for an arbitrary energy density ratio of the coherent wave to the fluctuation field, although the condition of weak turbulence is imposed throughout the analysis.

Yang, J. N.

Y01 ON THE BOUND OF FIRST EXCURSION PROBABILITY
Yang, J. N., Shinozuka, M.
Technical Report 32-1304, August 15, 1968 (Unclassified)

Because of its direct relation to the reliability or the safe performance of mechanical and structural systems subjected to random external disturbances, the bounding technique of the first excursion probability is studied. In particular, the

lower bound of the probability proposed previously is improved. Numerical examples indicate that the improvement is significant.

The present method of improvement requires the knowledge of the joint density function of the random process at two arbitrary instants. Other than this, the method is universal; it can apply to stationary or nonstationary, gaussian or nongaussian processes.

General expressions for lower and upper bounds are also derived in this study and their potential usefulness is pointed out.

Y02 A NOTE ON THE FIRST PASSAGE TIME PROBLEM
Yang, J. N., Shinozuka, M.
Technical Report 32-1334, October 15, 1968
(Unclassified)

An analytical formulation of the first passage time problem for a linear single-degree-of-freedom vibratory system with linear viscous damping, and subjected to either stationary or nonstationary white noise excitation, is obtained as a well posed initial-boundary value problem. The formulation is based on the Kolmogorov backward equation, rather than the Fokker–Planck equation. This note should provide a valuable insight to the problem and serve as an important foothold for the future study in which, it is hoped, an efficient numerical integration scheme can be found.

Y03 A MATHEMATICAL MODEL OF THE EFFECT OF A PREDATOR ON SPECIES DIVERSITY
Yang, J. N., Weston, C. R.
Technical Report 32-1359, June 15, 1969
(Unclassified)

The presence of two species in the same environment with a common limiting resource is paradoxical if competition for the limiting resource is the only consideration. One or the other of the species must be eliminated. This analysis shows that a normally unsuccessful competitor for the limiting resource may persist when there is a predator on the otherwise successful species. The modified assumption and different parametric values which are considered do not alter

this generalization. The working model is that of bacteria growing in a chemostat; however, there is no reason to assume the resultant conclusions are restricted to a bacterial system, an experimental situation, or terrestrial organisms.

Ziv, M.

Z01 ELASTIC WAVE PROPAGATION FOR PLANE STRAIN PROBLEMS BY THE THEORY OF CHARACTERISTICS
Ziv, M.
Technical Report 32-1308, February 29, 1968
(Unclassified)

A method is presented by which the theory of characteristics is extended to include elastic waves in two-spatial dimensions. This method makes use of Hadamard's work on surfaces of discontinuity in the dependent variables and their derivatives.

A model is developed for a surface propagating in a linear elastic, isotropic, and homogeneous medium. Velocities and stresses of the material particles are assumed to be discontinuous in their first partial derivatives across the propagating surface. A transformation is used for this model by which the relevant discontinuity relations from Hadamard's theory are applied to the dynamical field equations. Application of this transformation results in a system of necessary dynamical conditions, which then lead to the derivation of the characteristic equations for two-spatial dimensions. Not only are these characteristic equations shown to contain the well known one-spatial dimensional form, but they also accommodate more complex cases encountered in one-spatial dimensional wave problems.

The derived characteristic equations are applied to the numerical evaluation of two representative boundary-value problems. The first is essentially a one-spatial dimensional problem and consists of a uniform plane oblique load suddenly applied on an infinite flat plate. Velocities and stresses are computed for the entire spatial solution domain. The second is a two-spatial dimensional problem and consists of a line load suddenly applied on a half-space. Here velocities and stresses are computed on the surface of the half-space at the leading wave front.

Space Programs Summary

The Space Programs Summary (SPS) is a multivolume, bimonthly publication that presents a review of technical information resulting from current engineering and scientific work performed, or managed, by the Jet Propulsion Laboratory for the National Aeronautics and Space Administration.

AB01 FLIGHT PROJECTS

Space Programs Summary, Vol. I (Unclassified)

37-51, March 1 to April 30, 1968,
May 31, 1969
37-52, May 1 to June 30, 1968,
July 31, 1968
37-53, July 1 to August 31, 1968,
September 30, 1968
37-54, September 1 to October 31, 1968,
November 30, 1968
37-55, November 1 to December 31, 1968,
January 31, 1969
37-56, January 1 to February 28, 1969,
March 31, 1969

This volume describes the current technological products and activities of the flight projects of the JPL/NASA Planetary-Interplanetary Program. Specific subjects covered include: space exploration vehicles and their associated subsystems, ground support equipment, engineering and scientific instruments, special test and handling fixtures, and interface hardware.

AB02 THE DEEP SPACE NETWORK

Space Programs Summary, Vol. II (Unclassified)

37-51, March 1 to April 30, 1968,
May 31, 1968
37-52, May 1 to June 30, 1968,
July 31, 1968
37-53, July 1 to August 31, 1968,
September 30, 1968
37-54, September 1 to October 31, 1968,
November 30, 1968
37-55, November 1 to December 31, 1968,
January 31, 1969
37-56, January 1 to February 28, 1969,
March 31, 1969

This volume describes the current technological products and activities of the JPL/NASA Deep Space Network (DSN). The DSN consists of the Deep Space Instrumentation Facility, Space Flight Operations Facility, and the Ground Communications Facility. Specific subjects covered include: tracking, communication, computational, and display systems, subsystems, and components; special test and handling fixtures; computer programs; research and development hardware; and technical structures.

AB03 SUPPORTING RESEARCH AND ADVANCED DEVELOPMENT

Space Programs Summary, Vol. III (Unclassified)

37-50, February 1 to March 31, 1968,
April 30, 1968
37-51, April 1 to May 31, 1968,
June 30, 1968
37-52, June 1 to July 31, 1968,
August 31, 1968
37-53, August 1 to September 30, 1968,
October 31, 1968
37-54, October 1 to November 30, 1968,
December 31, 1968
37-55, December 1, 1968 to January 31, 1969,
February 28, 1969

This volume describes the current technological activities of the JPL/NASA supporting research and advanced development tasks. The technical disciplines covered include: aerodynamics, celestial mechanics, chemistry, computer applications, electrical power generation, electronics, environmental simulators, fluid physics, guidance and control, instrumentation, materials, mathematics, microbiology, physical space sciences, physics, propellants, propulsion systems, quality assurance and reliability, structural mechanics, telecommunications, test facilities, and thermodynamics and combustion.

JPL Reporting in the Open Literature

This section lists engineering and scientific articles by JPL technical personnel which have been published in the open literature—either domestic or foreign. Articles from the open literature which have been reprinted and published as JPL Technical Reports are included in the preceding section, "Technical Reports and Memorandums."

Abhyankar, K. D.

TRANSFER OF RADIATION THROUGH INHOMOGENEOUS SLAB ATMOSPHERES

Fymat, A. L., Abhyankar, K. D.
The Astronomical Journal, Vol. 73, No. 10, Part II, December 1968 (Supplement)

For abstract, see Fymat, A. L.

SCATTERING OF VISIBLE RADIATION AROUND THE SPHERICAL ATMOSPHERE OF VENUS

Abhyankar, K. D.
ICARUS: International Journal of the Solar System, Vol. 9, No. 3, November 1968, pp. 507–525

The observed visual brightness of Venus at phase angles $\alpha > 120$ deg has been found to exceed the predicted theoretical brightness for isotropic and Rayleigh phase functions. Following a suggestion that the excess brightness is caused by the diffusion of radiation around the edge of the spherical atmosphere of Venus, approximate computations of the flux of this diffused radiation were made at various phase angles by assuming a Rayleigh phase function. By an appropriate geometrical consideration an attempt has been made to resolve this spherical problem into a series of separate problems which can be treated by the ordinary plane-parallel technique. This procedure permits the utilization of the available tables of scattering functions for plane Rayleigh atmospheres of different optical thicknesses. The standard model of Kaplan and a similar new model based on the recent Venera 4 and Mariner V data were used for obtaining the required optical depths. It is found that the computed fluxes account for only a small part of the excess observed brightness and it is concluded that the main contribution to the observed brightness of Venus at inferior conjunction comes from particulate matter, which scatters one order of magnitude more efficiently in the forward direction than a Rayleigh scatterer.

Adams, J. B.

LUNAR AND MARTIAN SURFACES: PETROLOGIC SIGNIFICANCE OF ABSORPTION BANDS IN THE NEAR-INFRARED

Adams, J. B.
Science, Vol. 159, March 29, 1968, pp. 1453–1455

A reflection minimum at 1 micron, reported for moon and for Mars, indicates olivine or iron- and calcium-bearing clinopyroxene, or both; these are major constituents of many basaltic rocks. If the 1-micron absorption features are real, both chondritic and acidic rocks are ruled out as primary constituents of the surfaces of the bodies. The reflectance spectrum of Mars matches closely that of an oxidized basalt.

Anderson, J. D.

MASS, DYNAMICAL OBLATENESS, AND POSITION OF VENUS AS DETERMINED BY MARINER V TRACKING DATA

Anderson, J. D., Efron, L., Pease, G. E.
The Astronomical Journal, Vol. 73, No. 10, Part II December 1968 (Supplement)

The close approach to Venus by Mariner V on October 19, 1967 has provided a unique opportunity to accurately determine the mass, dynamical oblateness, and location of the center of mass of the planet. The mass has been obtained from a least-squares solution to two-way doppler data taken in a 10-day interval centered about closest approach. The Venus gravitational constant thus determined is 324859.23 ± 0.19 km^3/s^2 leading to a sun/Venus mass ratio of 408523.10 ± 0.24, assuming a value of 149,597,896 km for the astronomical unit or equivalently a value of $1,327,125 \times 10^5$ km^3/s^2 for the gravitational constant of the sun. The oblateness of the gravitational field of Venus is very low compared with that of earth. The Mariner V encounter data yield a value of $(8.4 \pm 3.9) \times 10^{-6}$ for the second-order zonal harmonic coefficient J_2. It is unlikely that the dynamical oblateness of Venus

is greater than 0.01 the value for earth. The position of Venus at the time of closest approach of *Mariner V* has been determined from spacecraft ranging and doppler data and the indicated geocentric correction to the latest JPL radar ephemeris (Development Ephemeris 40) is less than 31 km. The largest component, 28 km (0.07s), is in the declination direction.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M., Melbourne, W. G., O'Handley, D. A., Pease, G. E., Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6, November 1968, pp. 1171–1173

During 1967, time-delay measurements from Venus radar bounce signals were obtained that overlapped the range and doppler radio tracking measurements of the *Mariner V* spacecraft as it flew by Venus in October 1967. The near simultaneity of the radar bounce and radio tracking measurements allows the radius of Venus to be determined by two different methods.

Through the perturbation by Venus on the orbit of *Mariner V* during the encounter phase, the position (also the velocity and mass) of the center of gravity of Venus can be determined very accurately from radio tracking data. The resulting geocentric range of the center of gravity of Venus at a particular epoch, i.e., the encounter time of *Mariner V*, may be compared with an interpolated value (at this same epoch) of the radar time-delay measurements. Since the time-delay measurements of radar bounce signals are referenced from the sub-earth point on the surface of Venus, a value of the radius can be directly inferred from the difference in the values obtained by these two measurement types. A variant of this method treats the difference between simultaneous time-delay radar bounce measurements and the spacecraft ranging measurements as the basic data type which, by data processing, leads to a radius value on which trajectory and ephemeris errors have a second order effect.

The second method for determining the radius is through the processing of radar bounce measurements alone. Here, the radius as well as the orbital parameters of the planet and the earth are determined simultaneously. These methods for obtaining the radius of Venus and their results are briefly described.

Anderson, V. E.

GROUND-STATE ENERGY EIGENVALUES AND EIGENFUNCTIONS FOR AN ELECTRON IN AN ELECTRIC-DIPOLE FIELD

Turner, J. E., Anderson, V. E. (Oak Ridge National Laboratory)
Fox, K. (Jet Propulsion Laboratory)
Physical Review, Vol. 174, No. 1, October 5, 1968, pp. 81–89

For abstract, see Turner, J. E.

Atkinson, G.

TWO-DIMENSIONAL CHAPMAN-FERRARO PROBLEM WITH NEUTRAL SHEET
1. THE BOUNDARY

Unti, T., Atkinson, G.
Journal of Geophysical Research, Space Physics, Vol. 73, No. 23, December 1, 1968, pp. 7319–7327

For abstract, see Unti, T.

Baldwin, J. A., Jr.

A METHOD FOR THE MEASUREMENT OF DOMAIN-WALL ENERGY DENSITY IN THIN MAGNETIC FILMS

Baldwin, J. A., Jr.
Journal of Applied Physics, Vol. 4, No. 1, January 1969, pp. 432–433

No abstract available.

Beauchamp, J. L.

ION CYCLOTRON RESONANCE OF OLEFINS.
I. A STUDY OF THE ION-MOLECULE REACTIONS IN ELECTRON-IMPACTED ETHYLENE

Bowers, M. T., Elleman, D. D. (Jet Propulsion Laboratory)
Beauchamp, J. L. (California Institute of Technology)
Journal of Physical Chemistry, Vol. 72, No. 10, October 1968, pp. 3599–3612

For abstract, see Bowers, M. T.

Beaudet, R. A.

THE MICROWAVE SPECTRA, MOLECULAR STRUCTURE, AND DIPOLE MOMENT OF PHOSPHIRANE

Bowers, M. T., Beaudet, R. A. (Jet Propulsion Laboratory)
Goldwhite, H. (University of Southern California)
Tang, R. (California State College at Los Angeles)
Journal of the American Chemical Society, Vol. 91, No. 17, 1969, pp. 17–20

For abstract, see Bowers, M. T.

IMPROVED SWEEP MODULATOR FOR HIGH dc VOLTAGES

Remeikes, A., Beaudet, R. A. (University of Southern California)
Poynter, R. L., Steffensen, G. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 39, No. 8, August 1968, pp. 1223–1224

No abstract available.

PREDICTIONS OF SEVERAL OH Λ DOUBLING TRANSITIONS SUITABLE FOR RADIO ASTRONOMY

Poynter, R. L. (Jet Propulsion Laboratory)
Beaudet, R. A. (University of Southern California)

No abstract available.

Behr, C. G.

DYADIC ANALYSIS OF SPATIALLY HOMOGENEOUS WORLD MODELS

Estabrook, F. B., Wahlquist, H. D., Behr, C. G.

For abstract, see Estabrook, F. B.

Billingsley, F. C.

A DIGITAL IMAGE PROCESSING RATIONALE

Billingsley, F. C.

A brief discussion is presented of the kinds of image processing that can be accomplished and of some of the possible techniques. Digital processing is shown to be a flexible and convenient method.

A rationale is then built up for the hardware system required to either scan or produce films. The discussion covers resolution available in practical systems, quantities of data involved and problems of quantization, particularly as affected by noise. From this, allowable film density granularity and system signal-to-noise ratio may be derived and an estimate made of the scanning and digitizing speed.

In addition to the rather stringent scanning or reproducing requirements, the efficient handling of data in a computer is of great importance. This is true both for the case of experimentation which requires rapid turn-around to the experimenter, and for production processing which requires efficient handling of many pictures. The latter part of the paper discusses these factors and shows what attempts are being made at Jet Propulsion Laboratory to satisfy both sets of requirements.

Bowers, M. T.

KINETIC ANALYSIS OF THE ION–MOLECULE REACTIONS IN NITROGEN–HYDROGEN MIXTURES USING ION CYCLOTRON RESONANCE

Bowers, M. T. (University of California)
Elleman, D. D., King, J., Jr. (Jet Propulsion Laboratory)

The thermal energy rate constants for the reactions

$$N_2^+ + D_2 \xrightarrow{k_1} N_2D^+ + D$$

$$N_2^+ + H_2 \xrightarrow{k_3} N_2H^+ + H$$

$$N_2^+ + HD \xrightarrow{k_{4a}} N_2H^+ + D$$

$$\xrightarrow{k_{4b}} N_2D^+ + H$$
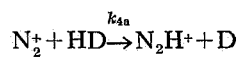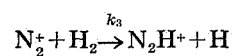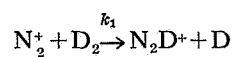
have been measured using ion cyclotron resonance giving $k_1 = 1.15$, $k_3 = 1.41$, $k_{4a} = 0.65$, and $k_{4b} = 0.69 \times 10^{-9}$ cm^3 molecule^{-1}·sec^{-1}. These results agree well with the values calculated from the change-induced dipole model of Gioumousis and Stevenson. The absence of a significant isotope effect in k_{4a} and k_{4b} indicates that these reactions proceed via a stripping mechanism. Energy dependence studies of k_2 and the corresponding charge exchange rate constant k_5

$$D_2^+ + N_2 \xrightarrow{k_2} N_2D^+ + D$$

$$D_2^+ + N_2 \xrightarrow{k_5} D_2 + N_2^+$$
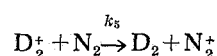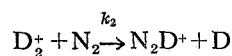
indicate that the decrease in k_2 with increasing reactant ion energy is approximately offset by the increase in k_5 as predicted by the phase–space theory of light.

THE MICROWAVE SPECTRA, MOLECULAR STRUCTURE, AND DIPOLE MOMENT OF PHOSPHIRANE

Bowers, M. T., Beaudet, R. A. (Jet Propulsion Laboratory)
Goldwhite, H. (University of Southern California)
Tang, R. (California State College at Los Angeles)

The microwave spectra of phosphirane, phosphirane-^{13}C, cis- and trans-phosphirane-C-d_1, and phosphirane-P-d have been studied. From these isotopes the following molecular structure was determined: $r(C-C) = 1.502$ Å, $r(C-P) = 1.867$ Å, $r(C-H_{cis}) = 1.092$ Å, $r(C-H_{trans}) = 1.093$ Å, $r(P-H) = 1.438$ Å, $\angle CPC = 47.4$ deg, $\angle HCH = 114.4$ deg, $\angle H - PC_2$ (plane) $= 95.7$ deg, $\angle H-P-C = 95.2$ deg, and $\angle C-C-H_{cis} = 118.0$ deg, $\angle C-C-H_{trans} = 117.5$ deg. A dipole moment of 1.12 D and its orientation were also obtained.

ION CYCLOTRON RESONANCE OF OLEFINS. I. A STUDY OF THE ION-MOLECULE REACTIONS IN ELECTRON-IMPACTED ETHYLENE

Bowers, M. T., Elleman, D. D. (Jet Propulsion Laboratory)
Beauchamp, J. L. (California Institute of Technology)

Ion cyclotron single- and double-resonance spectroscopy has been employed to identify and study the kinetics and energetics of ion–molecule reactions of the principal primary

ions derived from ethylene. The measured relative rate constants determined using cyclotron resonance techniques are in good agreement with previously published values. The behavior of reaction rate constants above thermal ion energies has been qualitatively examined using double-resonance techniques. In cases where several product ions originate from a single reactant, it is shown that, while the partitioning of reaction products depends strongly on ion energy, the total number of reactive encounters remains essentially unchanged. Information concerning the nature and lifetimes of the collision complexes formed in ion–molecule encounters has been derived from an analysis of single-resonance relative intensities and line widths.

Brinkmann, R. T.

ANGULAR DEPENDENCE OF LOW-ENERGY EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H$_2$

Trajmar, S., Brinkmann, R. T. (Jet Propulsion Laboratory)
Rice, J. K., Kuppermann, A.(California Institute of Technology)
Cartwright, D. C. (Institute for Extraterrestrial Physics)
The Journal of Chemical Physics, Vol. 49, No. 12, December 15, 1968, pp. 5464–5472

For abstract, see Trajmar, S.

Cain, D. L.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M., Melbourne, W. G., O'Handley, D. A., Pease, G. E., Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6, November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

MARINER 5 AND THE RADIUS OF VENUS

Kliore, A., Cain, D. L.
Journal of Atmospheric Sciences, Vol. 25, No. 4, July 1968, pp. 549–554

For abstract, see Kliore, A.

Cameron, R. E.

SOIL MOISTURE, RELATIVE HUMIDITY, AND MICROBIAL ABUNDANCE IN DRY VALLEYS OF SOUTHERN VICTORIA LAND

Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 4, No. 1, January–February 1969, pp. 23–28

In situ moisture and relative humidity were determined at four sites for approximately 1 wk periods in dry valleys of southern Victoria Land in Antarctica. Moisture and relative humidity were found to increase with proximity to icy permafrost (subsurface frozen ground table). Correlations were shown between the moisture status of the soil and the numbers and kinds of microorganisms. The increase in diversity and abundance of microflora from McKelvey to Victoria to King–David to Wheeler Valleys is the result of favorable changes in ecological factors. These changes are based primarily on increases in favorable moisture–temperature (solclime) conditions and associated soil (edaphic) properties.

ANTARCTIC DRY VALLEY SOIL MICROBIAL INCUBATION AND GAS COMPOSITION

Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 4, No. 1, January–February 1969, pp. 28–33

The abundance of microflora was determined for soil samples from Taylor Valley, Antarctica. After incubation of moistened samples for 4 mo in specially designed chambers, the microbial abundance was calculated. Results indicated a substantial increase in microflora in the moistened surface sample compared to the subsurface sample. Air samples taken above the soil surface and from within the soil profile did not indicate any significant variation of O_2, CO_2, N_2, or Ar, whether from the air above the soil or within the soil profile; however, air from the incubator samples and at McMurdo station showed significantly higher concentrations of CO_2.

SOIL TOXICITY IN ANTARCTIC DRY VALLEYS

Cameron, R. E., David, C. N., King, J.
Antarctic Journal of the United States, Vol. 3, No. 5, September–October 1968, pp. 164–165

Soils collected from the Asgard Range (Matterhorn and King–David Valleys) were tested for toxicity because they contained no detectable microorganisms. It was found that incubation of viable and nonviable soils gave evidence for two primary factors in soil sterility: (1) presence of high concentrations of boron and salts in a moist soil, and (2) unfavorable environmental factors, especially desiccation. This study suggests that toxicity is responsible for the absence or near absence of microorganisms in three Antarctic soil samples among those tested.

ANTARCTIC SIMULATOR FOR SOIL STORAGE AND PROCESSING

Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 3, No. 5, September–October 1968, pp. 219–220

During the Antarctic summers of 1966–1967 and 1967–1968, more than 2.5 tons of soils and rocks (146 samples) were collected from 55 sites in the dry valleys of southern Victoria Land and on Ross Island. All samples were kept in the frozen state and shipped to the Jet Propulsion Laboratory. At the

Laboratory a portable U.S. Navy walk-in freezer was modified to house the samples which are catalogued and stored at -30 to $-26°C$ and where all of the Antarctic samples are processed in a specially designed and equipped isolation booth. The freezer also serves as a cold-environment-chamber to test instruments and train personnel for Antarctic field trips.

SOIL MICROBIAL AND ECOLOGICAL STUDIES IN SOUTHERN VICTORIA LAND
Cameron, R. E., King, J., David, C. N.
Antarctic Journal of the United States, Vol. 3, No. 4, July–August 1968, pp. 121–123

Five temporary field sites were established in the dry valleys of southern Victoria Land during Antarctic summers of 1966–1967 and 1967–1968. Studies were made of cold desert soil microbial ecology which are relevant to detection and quarantine of life on Mars. Based on environmental measurements, soil properties, and the distribution, abundance, and kinds of microorganisms, favorable and unfavorable ecologic factors were listed that determine the presence or absence of life in these valleys. The maximum total abundance of microorganisms varied from zero (undetectable), to approximately $10^5/g$ of soil. In three out of every four sites investigated, the subsurface microflora were more abundant than those on the surface. Nonpigmented bacteria were generally more abundant than pigmented species and were the only life forms present in the driest valleys. No anaerobes or bacteriophages were found.

Capen, C. F.
THE PLANET MARS IN 1969
Capen, C. F., Capen, V. W.
Sky and Telescope, Vol. 37, No. 3, March 1969, pp. 190–194

The 1969 planetary aspects for observing the planet Mars are discussed. The Martian seasons, disk diameters, and axial tilts relative to the earth for given dates are presented and the current planetary appearance is shown in telescopic drawings and photographs made during 1967. Filter transmission curves and their use in observation are briefly reviewed.

Capen, V. W.
THE PLANET MARS IN 1969
Capen, C. F., Capen, V. W.
Sky and Telescope, Vol. 37, No. 3, March 1969, pp. 190–194

For abstract, see Capen, C. F.

Cartwright, D. C.
ANGULAR DEPENDENCE OF LOW-ENERGY EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H_2
Trajmar, S., Brinkmann, R. T. (Jet Propulsion Laboratory)

Rice, J. K., Kuppermann, A. (California Institute of Technology)
Cartwright, D. C. (Institute of Extraterrestrial Physics)
The Journal of Chemical Physics, Vol. 49, No. 12, December 15, 1968, pp. 5464–5472

For abstract, see Trajmar, S.

Chamberlain, R. G.
LAUNCH PROBABILITY MODELS FOR A SINGLE SPACE VEHICLE
Chamberlain, R. G.
Journal of Spacecraft and Rockets, Vol. 5, No. 7, July 1968, pp. 860–863

The desire to maximize information return from space missions has led to considerable research at the Jet Propulsion Laboratory to determine the tradeoffs between launch period lengths and launch probabilities. Although this note presents some of the results for the launch of a single space vehicle, the problem considered has general applicability and is stated as: how long will it take to realize an event when each trial can either succeed or lead to a delay followed by another trial? This question is dealt with in terms of probability distributions.

Chen, C. J.
COLLISIONAL–RADIATIVE ELECTRON–ION RECOMBINATION RATE IN RARE-GAS PLASMAS
Chen, C. J.
The Journal of Chemical Physics, Vol. 50, No. 4, February 15, 1969, pp. 1560–1566

The minimum de-excitation rate of a recombining electron in the atom is calculated by using Gryzinski's formulation for the electron–atom collision process and Bates and Damgaard's Coulomb approximation for the radiative transition probability. The calculated minimum rate is taken to be the electron–ion collisional–radiative recombination rate, which is measured in a decaying plasma produced by a transient discharge. The comparison between the theoretical calculations and experimental results for five rare-gas (He, Ne, Ar, Kr, and Xe) plasmas is presented.

TEMPERATURE DEPENDENCE OF DISSOCIATIVE RECOMBINATION AND MOLECULAR-ION FORMATION IN He, Ne, AND Ar PLASMAS
Chen, C. J.
Physical Review, Vol. 177, No. 1, January 5, 1969, pp. 245–254

Recombination-dominated decaying plasmas in He, Ne, and Ar gases are produced in a discharge tube energized with a capacitor bank capable of delivering 3×10^3 J at 20 kV. The electron temperature, atom temperature, and electron number

density as a function of time are measured by using a triple probe, a thin-film thermometer, and the triple probe and microwave apparatus, respectively. The atomic- and molecular-ion number densities are monitored by using a mass spectrometer. The electron-temperature dependence of the dissociative recombination coefficient α_2, and the atom-temperature dependence of the molecular-ion formation coefficient γ are calculated. The results indicate the following: (1) the electron-temperature dependence and absolute value of α_2 are both affected by the atom temperature of the plasma; a simplified physical model is proposed to explain this variation of dependence; the previous controversial experimental results published in the literature on this subject can be understood with the use of this physical model; and (2) the atom-temperature dependence of γ agrees with theoretical expectations.

Christiansen, W. H.

MEASUREMENTS OF FLOW UNIFORMITY IN SHOCK TUBES OPERATING AT LOW INITIAL PRESSURE
Christiansen, W. H.
The Physics of Fluids, Vol. 11, No. 10
October 1968, pp. 2279–2281

The rate of heat transfer to fine wire probes was used to measure the flow nonuniformity in a shock tube. Some systematic differences were observed between the measured quantities and those calculated using the theory of Mirels.

Conel, J. E.

INFRARED EMISSIVITIES OF SILICATES: EXPERIMENTAL RESULTS AND A CLOUDY ATMOSPHERE MODEL OF SPECTRAL EMISSION FROM CONDENSED PARTICULATE MEDIUMS
Conel, J. E.
Journal of Geophysical Research, Vol. 74, No. 6,
March 15, 1969, pp. 1614–1634

Infrared emissivities of powered silicates are shown by experiment to contain new maximums and minimums that are representative of both composition and particle size. A cloudy atmosphere model for radiative transfer in a condensed powder is developed in which the scatter is considered to be both nonconservative and linearly anisotropic. The scattering parameters are computed as functions of frequency from the Mie diffraction theory and detailed calculations of the spectral emissivity of quartz are presented. The model is shown to account for many features observed experimentally in the spectra of quartz powders and sand. Changes in the spectrum with particle size can be understood in terms of changes in the albedo for single scattering and the degree of forward scatter with particle size. The principal Christiansen frequencies of silicate powder films obtained from transmission measurements are shown to be diagnostic of mineralogy and to be frequencies of maximum emissivity for powders. This relationship is discussed in detail for quartz.

LUNAR MASCONS: A NEAR-SURFACE INTERPRETATION
Conel, J. E., Holstrom, G. B.
Science, Vol. 162, December 20, 1968, pp. 1403–1405

The gravitational effect of lunar mascons has been studied by gravity modeling. A north–south profile across Mare Serenitatis can be fitted by either a thin tabular body at the lunar surface or a deep sphere ($\sim$200 km below the moon's surface). Reasons for preferring the former are suggested.

Connor, B. V.

SPACE MAGNETICS: THE MARINER V MAGNETOMETER EXPERIMENT
Connor, B. V.
IEEE Transactions on Magnetics, Vol. MAG-4, No. 3,
September 1968, pp. 391-397

The performance of a scientific magnetics experiment in space involves the selection, development, and calibration of an instrument capable of satisfying the requirements of the scientific objectives. Since stray magnetic fields produced by the spacecraft can be a source of measurement error, the design and magnetic testing of all the flight hardware are also factors in meeting scientific objectives. These considerations are discussed as embodied in the *Mariner V* effort. The relatively new and successful vector helium magnetometer used for *Mariner IV* and *Mariner V* is described. Also presented are the efforts to reduce the *Mariner* spacecraft stray fields and the results of those efforts. Finally, a brief description of the special facilities used for testing and evaluation and a summary of the final experiment results are given.

Conrow, H. P.

SOIL MOISTURE, RELATIVE HUMIDITY, AND MICROBIAL ABUNDANCE IN DRY VALLEYS OF SOUTHERN VICTORIA LAND
Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 4, No. 1,
January–February 1969, pp. 23–28

For abstract, see Cameron, R. E.

ANTARCTIC DRY VALLEY SOIL MICROBIAL INCUBATION AND GAS COMPOSITION
Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 4, No. 1,
January–February 1969, pp. 28–33

For abstract, see Cameron, R. E.

ANTARCTIC SIMULATOR FOR SOIL STORAGE AND PROCESSING
Cameron, R. E., Conrow, H. P.
Antarctic Journal of the United States, Vol. 3, No. 5,
September–October 1968, pp. 219–220

For abstract, see Cameron, R. E.

David, C. N.

SOIL TOXICITY IN ANTARCTIC DRY VALLEYS

Cameron, R. E., David, C. N., King, J.
Antarctic Journal of the United States, Vol. 3, No. 5,
September–October 1968, pp. 164–165

For abstract, see Cameron, R. E.

SOIL MICROBIAL AND ECOLOGICAL STUDIES IN SOUTHERN VICTORIA LAND

Cameron, R. E., King, J., David, C. N.
Antarctic Journal of the United States, Vol. 3, No. 5,
July–August 1968, pp. 121–123

For abstract, see Cameron, R. E.

DeMore, W. B.

REACTIONS OF O(^{1}D) WITH HYDROCARBONS IN LIQUID ARGON

DeMore, W. B.
The Journal of Physical Chemistry, Vol. 73, No. 2,
February 1969, pp. 391–395

Photolysis of O_3 (2537 Å) in dilute solutions in liquid argon has been used to study the reactions of O(^{1}D) with several hydrocarbons and also with C_2F_4. In the case of the alkanes, the major products were the corresponding alcohols formed by insertion of O(^{1}D) into the C—H bonds in an indiscriminate manner. Reactions involving removal of two H atoms occurred to the extent of about 3% of the overall reactions of O(^{1}D) with both alkanes and alkenes. For ethane and the higher alkanes, there was no evidence for the production of radicals which could be scavenged by O_2, unlike previous results with H_2 and CH_4. The relative rates of O(^{1}D) attack on alkanes were found to be proportional to the number of C—H bonds present, but independent of the type. The evidence was that the C=C bond is attacked five times as rapidly as a C—H bond.

Deo, N.

GENERALIZED PARALLEL REDUNDANCY IN DIGITAL COMPUTERS

Deo, N.
IEEE Transactions on Electronic Computers, Vol. EC-17,
No. 6, June 1968, p. 600

Triple modular redundancy becomes common when applications place a high premium on the reliability of a digital computer. As the weight, volume, and cost of electronic components decrease, 5-, 7-, or 9-fold redundancies should be considered. This short note presents expressions on the reliabilities of a general *n*-fold redundant system.

OPTIMIZATION OF HARDWARE REDUNDANCY IN SPACE COMPUTERS

Deo, N.
Annual Technical Conference Transactions 1968,
Philadelphia, Penn., May, pp. 389–396. American Society
for Quality Control, Milwaukee, Wis.

In view of the long life required of a digital computer in space, and the severe constraints on the computer's weight and power consumption, it is obvious that a simple Triple-Modular-Redundancy will not do. A more efficient and sophisticated design, taking "demand pattern" into consideration, has to be evolved. This paper gives the results of the first phase of research directed toward the goal of achieving maximum reliability from a given amount of hardware.

de Wys, J. N.

MAGNET EXPERIMENT: ELECTROMAGNETIC PROPERTIES OF THE LUNAR SURFACE

de Wys, J. N.
Journal of Geophysical Research, Vol. 73, No. 22,
November 15, 1968, pp. 7193-7208

A permanent magnet and nonmagnetic control bar attached to a footpad of *Surveyor* V represent the first magnetic experiment on lunar mare material. This magnet assembly revealed the presence of magnetic material in Mare Tranquillitatis, the *Surveyor* V landing site. Television pictures showed relatively small amount of magnetic material adhering to the magnet. All particles appeared to be smaller than camera resolution. The pictures have been compared in detail with various laboratory simulations of impact in powdered rock types with and without additions of powdered iron. The closest laboratory analogy was found in powdered basalt (37 to 50 μ) with no addition of powdered iron.

SURVEYOR VI MAGNET EXPERIMENT

de Wys, J. N.
Journal of Geophysical Research, Vol. 75, No. 22,
November 15, 1968, pp. 6915–6924

A magnet assembly consisting of a magnetized bar and an unmagnetized bar was attached to a footpad of *Surveyor* VI in such a manner that it would permit viewing by the television camera following the lunar landing of the spacecraft and after the assembly had made contact with the lunar surface. Results of the experiment indicate that there is a small amount of magnetic material present in the Sinus Medii and appear to support a basaltic composition. This experiment strengthens the conclusion that basaltic composition may dominate the maria units, and the basalt may be scoriaceous. In addition, the magnet experiments lend support to a volcanic origin of this mare material, and would further suggest fine particles at the time of origin, rather than subsequent pulverization by impact.

PERMAFROST FEATURES ON THE MARTIAN SURFACE
Wade, F. A., de Wys, J. N.
ICARUS: International Journal of the Solar System,
Vol. 9, No. 1, July 1968, pp. 175–185

For abstract, see Wade, F. A.

Dolan, J. F.

X-RAY EMISSION FROM CYGNUS XR-1
Metzger, A. E., Dolan, J. F.
The Astronomical Journal, Vol. 73, No. 5,
Part II, June 1968 (Supplement)

For abstract, see Metzger, A. E.

Drummond, A. J.

SOLAR CONSTANT: FIRST DIRECT MEASUREMENTS
Laue, E. G. (Jet Propulsion Laboratory)
Drummond, A. J. (Eppley Laboratory)
Science, Vol. 161, August 30, 1968, pp. 888–891

For abstract, see Laue, E. G.

Efron, L.

MASS, DYNAMICAL OBLATENESS, AND POSITION OF VENUS AS DETERMINED BY MARINER V TRACKING DATA
Anderson, J. D., Efron, L., Pease, G. E.
The Astronomical Journal, Vol. 73, No. 10, Part II
December 1968 (Supplement)

For abstract, see Anderson, J. D.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA
Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M.,
Melbourne, W. G., O'Handley, D. A., Pease, G. E.,
Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6,
November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

Elleman, D. D.

KINETIC ANALYSIS OF THE ION–MOLECULE REACTIONS IN NITROGEN–HYDROGEN MIXTURES USING ION CYCLOTRON RESONANCE
Bowers, M. T. (University of California)
Elleman, D. D., King, J., Jr. (Jet Propulsion Laboratory)
The Journal of Chemical Physics, Vol. 50, No. 4,
February 15, 1969, pp. 1840–1845

For abstract, see Bowers, M. T.

ION CYCLOTRON RESONANCE OF OLEFINS.
I. A STUDY OF THE ION-MOLECULE REACTIONS IN ELECTRON-IMPACTED ETHYLENE
Bowers, M. T., Elleman, D. D. (Jet Propulsion Laboratory)
Beauchamp, J. L. (California Institute of Technology)
Journal of Physical Chemistry, Vol. 72, No. 10,
October 1968, pp. 3599–3612

For abstract, see Bowers, M. T.

Estabrook, F. B.

DYADIC ANALYSIS OF SPATIALLY HOMOGENEOUS WORLD MODELS
Estabrook, F. B., Wahlquist, H. D., Behr, C. G.
Journal of Mathematical Physics, Vol. 9, No. 4,
April 1968, pp. 497–504

Dyadic formalism is applied to cosmological models and leads to a convenient set of first-order ordinary differential equations. The Bianchi–Behr type of any model is shown to be constant in time, regardless of the state of the matter content. The case of perfect fluid matter content is formulated; Type V models and Type VIII and IX models with incoherent matter are discussed, and some consistent subtypes delineated. The Gödel Hamiltonian for symmetric Type IX models is also derived and generalized.

Fedors, R. F.

A SIMPLE MODEL FOR THE VIRTUALLY CROSSLINKED BLOCK COPOLYMERS
Fedors, R. F.
Journal of Polymer Science, Part C, No. 26, 1969,
pp. 189–199

A simple model is presented for the virtual crosslink effect in triblocks of the type A–B–A, where A is a segment having a relatively high glass transition temperature (T_g) and B is a segment having a relatively low T_g value. It is assumed that phase relationships can be estimated by using the thermodynamics of polymer mixtures, but certain constraints are imposed on the morphology of phases by the fact that different segments are chemically attached to each other. According to the model, at least two requirements are necessary for a block copolymer to behave as a chemically vulcanized elastomer: (1) the A and B segments must be mutually insoluble, and (2) the A segment must have a higher T_g value than the maximum temperature for which the material will be expected to function. The size of the glassy domains is discussed along with the theory that the glassy domains function as both crosslinks and filler particles.

Fischbach, D. B.

DEFORMATION-INDUCED ANISOTROPY IN GLASSY CARBON
Fischbach, D. B.
Carbon, Vol. 7, 1969, pp. 196–198

A pronounced basal plane fiber texture is developed in an initially isotropic nongraphitizing carbon by high temperature tensile deformation. This behavior implies certain structural characteristics for this carbon and may also have applications significance.

Flandro, G. A.

SOLAR ELECTRIC LOW-THRUST MISSIONS TO JUPITER WITH SWINGBY CONTINUATION TO THE OUTER PLANETS

Flandro, G. A.
Journal of Spacecraft and Rockets, Vol. 5, No. 9,
September 1968, pp. 1029–1033

The advantages of combining the Jupiter swingby technique with optimized solar electric propulsion for missions to the outer planets are evaluated. Significant payload gains are achieved without sacrificing the reduced trip time that results from energy gained in the Jupiter encounter. Use of low-thrust propulsion on the earth–Jupiter leg of the trajectory increases the payload by a factor of 3 for the standard *Atlas/Centaur* launch vehicle. Of particular interest is the "grand tour mission" to Jupiter, Saturn, Uranus, and Neptune, which is best launched in 1977.

Fox, K.

SPHERICAL PENDULUM AND MOTION IN A DIPOLE FIELD

Fox, K.
American Journal of Physics, Vol. 36, No. 11, Part 1,
November 1968, p. 1018

Some features of the classical bound motion of a charged particle in the field of a point electric dipole are obtained directly from known results for the motion of spherical pendulum.

GROUND-STATE ENERGY EIGENVALUES AND EIGENFUNCTIONS FOR AN ELECTRON IN AN ELECTRIC-DIPOLE FIELD

Turner, J. E., Anderson, V. E. (Oak Ridge National Laboratory)
Fox, K. (Jet Propulsion Laboratory)
Physical Review, Vol. 174, No. 1, October 5, 1968,
pp. 81–89

For abstract, see Turner, J. E.

INFRARED ABSORPTION SPECTRUM OF CH_4 AT 9050 cm^{-1}

Margolis, J. S., Fox, K.
The Journal of Chemical Physics, Vol. 49, No. 5,
September 1, 1968, pp. 2451–2452

For abstract, see Margolis, J. S.

THEORY OF THE COLLISION-INDUCED ROTATIONAL SPECTRUM OF TETRAHEDRAL MOLECULES

Ozier, I. (North American Rockwell Corporation)
Fox, K. (Jet Propulsion Laboratory)
Physics Letters, Vol. 27A, No. 5, July 15, 1968, pp. 274–275

For abstract, see Ozier, I.

Fymat, A. L.

TRANSFER OF RADIATION THROUGH INHOMOGENEOUS SLAB ATMOSPHERES

Fymat, A. L., Abhyankar, K. D.
The Astronomical Journal, Vol. 73, No. 10, Part II,
December 1968 (Supplement)

The auxiliary functions X, Y, X^*, and Y^* of Chandrasekhar and Ueno, which describe the transfer of radiation through an inhomogeneous plane-parallel slab atmosphere of arbitrary stratification, have been obtained by application of the authors' perturbation method. The system of multidimensional nonlinear singular integral equations satisfied by these functions has been simply linearized and its N solution given in the form of an infinite series of the Neumann type in the domain of convergence of the series. This solution is fairly accurate for most purposes; it can further be used as a starting approximation in the iterative process of determining the exact solution of the original nonlinear system. Illustrative examples and computational procedures are given.

The domain of applicability of the perturbation method has been investigated and X functions were computed for homogenous atmospheres with various albedos for single scattering in the entire range 0.0(0.1)1.06, i.e., for perturbations ω (τ) in these quantities covering the range $-1.0(0.2)+1.04$. The corresponding relative errors are shown as a function of the perturbation extreme value for various optical depths. These curves should be useful in selecting the appropriate signal scattering parameter Ω_0 that would minimize the errors in the linear solution. General rules are set forth for the most judicious choice of the couple (Ω_0, ω) of perturbation parameters for any given problem.

Gardner, J. A.

MINIMUM DETECTABLE LIMIT OF LITHIUM IN THE UPPER ATMOSPHERE

Gardner, J. A., Manring, E. R., Patty, R. R.
AIAA Journal, Vol. 6, No. 10, October 1968,
pp. 1997-2000

An experimental investigation was undertaken to establish limits on the emission rate of lithium in the upper atmosphere. The emission rates measured from 1958 to 1963 are believed to have been strongly influenced by high-altitude thermonuclear explosions detonated during that period. The present investigation was performed, using a birefringent photometer, during the four-month period between July and October

1966, with observations restricted to twilight skies that were free of any visible clouds or haze layers. Observations, using a similar technique, were also made on sodium in the upper atmosphere, and the results were compatible with published values. The lithium results exhibited none of the characteristics that would indicate the presence of lithium in the upper atmosphere at emission levels cited in the literature. Simulation of lithium in the atmosphere was performed by injecting a known level of 6707-Å radiation from a lithium hollow cathode lamp by a small mirror into the birefringent photometer while observing the twilight sky. The results of these injection measurements show that values of less than 1 Rayleigh could be detected. The conclusion reached is that the emission rate for lithium atoms above 65 km is less than 1 Reyleigh. This value constitutes an instrumental limit, since the experimental results never exhibited characteristics necessary for establishing the presence of lithium stratum in the upper atmosphere.

Goldstein, R. M.

RADAR TIME-OF-FLIGHT MEASUREMENTS TO VENUS

Goldstein, R. M.
Astronomical Journal, Vol. 73, No. 9, November 1968, p. 829

Measurements of the radar round-trip time of flight to Venus are given for the three-month interval about the inferior conjunction of August 1968.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M., Melbourne, W. G., O'Handley, D. A., Pease, G. E., Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6, November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

Goldwhite, H.

THE MICROWAVE SPECTRA, MOLECULAR STRUCTURE, AND DIPOLE MOMENT OF PHOSPHIRANE

Bowers, M. T., Beaudet, R. A. (Jet Propulsion Laboratory)
Goldwhite, H. (University of Southern California)
Tang, R. (California State College at Los Angeles)
Journal of the American Chemical Society, Vol. 91, No. 17, 1969, pp. 17–20

For abstract, see Bowers, M. T.

Gouw, R.

TESTING MODELS ON COMPRESSED SPECTRAL DATA

Haines, E. L., Parker, R. H. (Jet Propulsion Laboratory)
Gouw, R. (Informatics, Inc.)
Nuclear Instruments and Methods, Vol. 69, No. 1, March 1, 1969, pp. 11–20

For abstract, see Haines, E. L.

Gray, L. D.

COMPARISON OF PROCEDURES USED TO ANALYZE SPECTROSCOPIC OBSERVATIONS: THE 7820-Å CARBON DIOXIDE BAND IN THE SPECTRUM OF VENUS

Gray, L. D.
ICARUS: International Journal of the Solar System, Vol. 10, No. 1, January 1969, pp. 90–97

Four methods of data reduction are presented: two conventional ones, a slight modification of conventional methods, and a procedure designed to test one of the assumptions of the conventional approach. These have been used to analyze published data for the 7820-Å CO_2 band. A comparison of the rotational temperatures obtained from each method is given. For most of the Venus phase angles, the available data indicate that the lines in this band follow a square-root absorption law; however, in two cases out of ten, the lines appeared to follow a linear law.

AN UPPER LIMIT TO THE SURFACE PRESSURE OF VENUS

Young, A. T., Gray, L. D.
ICARUS: International Journal of the Solar System, Vol. 9, No. 1, July 1968, pp. 74–81

For abstract, see Young, A. T.

ON THE AMOUNT OF CARBON DIOXIDE IN THE ATMOSPHERE OF VENUS

Gray, L. D.
ICARUS: International Journal of the Solar System, Vol. 8, No. 3, May 1968, p. 518

No abstract available.

Greer, M. H.

PROGRESSIVE SURFACE MORPHOLOGICAL CHANGES OF MUSCLE FIBERS

Greer, M. H., Greer, R. T.
Proceedings of the Second Annual Scanning Electron Microscope Symposium, Chicago, Illinois, April 1969

The scanning electron microscope has been used to advantage to study a variety of muscle fibers from the femur of the

cockroach, *Periplaneta americana* (L.). The preparations have consisted of both fresh and fixed muscles with thin metallic coatings. The action of the beam causes a progressive, but systematic, degradation of the individual fibers. This appears as regular bands of openings around the fibers. Since transmission electron microscope studies of muscle thin sections have established a banded structure and the presence of openings (transverse tubules) in muscles, the observed degradation patterns can be interpreted as being structurally controlled and as corresponding to these transmission electron microscope findings.

Greer, R. T.

PROGRESSIVE SURFACE MORPHOLOGICAL CHANGES OF MUSCLE FIBERS
Greer, M. H., Greer, R. T.
Proceedings of the Second Annual Scanning Electron Microscope Symposium, Chicago, Illinois, April 1969

For abstract, see Greer, M. H.

Gronroos, H. G.

ENERGY DEPENDENT REMOVAL CROSS-SECTIONS IN FAST NEUTRON SHIELDING THEORY
Gronroos, H. G.
Engineering Compendium on Radiation Shielding,
Vol. I: Shielding Fundamentals and Methods,
Chap. 5.2.3.2, pp. 305–322, Springer-Verlag,
New York, 1968

The analytical approximations behind the energy dependent removal cross-section concept of Spinney are investigated and their predictions compared with exact values calculated by Case's singular integral method. The exact values are obtained in plane infinite geometry for the two absorption ratios $\Sigma_a/\Sigma_t = 0.1$ and 0.7 over a range of 20 mean free path and for varying degrees of forward anisotropy in the elastic scattering. The latter is characterized by choosing a suitable general scattering function.

It is shown that Spinney's original definition follows if Grosjean's formalism, i.e., the matching of moments, is applied. The prediction of the neutron flux is well within acceptable error bounds for thick neutron shield analysis. A definition of the removal cross-section based on matching the exact asymptotic solution to the exponential part of the approximate solution is found to give less accurate flux values than Spinney's method.

Gutmann, F.

ELECTRONIC PROPERTIES OF SOME TCNQ COMPLEXES
Rembaum, A., Hermann, A. M., Stewart, F. E., Gutmann, F.
The Journal of Physical Chemistry, Vol. 73, No. 3,
March 1969, pp. 513–520

For abstract, see Rembaum, A.

Haines, E. L.

DEGRADATION OF THE TIME CHARACTERISTICS OF SURFACE BARRIER DETECTORS WITH FISSION FRAGMENT DOSE
Mulás, P. (Instituto Politecnico Nacional, Mexico)
Haines, E. L. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 40. No. 3,
March 1969, pp. 507–509

For abstract, see Mulás, P.

TESTING MODELS ON COMPRESSED SPECTRAL DATA
Haines, E. L., Parker, R. H. (Jet Propulsion Laboratory)
Gouw, R. (Informatics, Inc.)
Nuclear Instruments and Methods, Vol. 69, No. 1,
March 1, 1969, pp. 11–20

This paper discusses a method by which information may be extracted from compressed spectral data in terms of a physical model. The spectral data may come from many different sources and a spectrum may be compressed into a finite sequence of orthogonal polynomial coefficients during data acquisition. The method used to extract the information from the compressed coefficients is the method of minimum-variance linear unbiased estimation. It provides a test of the validity of the chosen model, estimates of the parameters of the model, and an estimate of their covariance matrix.

Hall, R. C.

RESCUE AND RETURN OF ASTRONAUTS ON EARTH AND IN OUTER SPACE
Hall, R. C.
The American Journal of International Law, Vol. 63,
No. 2, April 1969, pp. 197–210

This article is concerned with the international legal implications of rescue and return of astronauts on earth and in outer space. Contemporary United States manned space flight programs and recognized modes for rescue operations are reviewed, and recent developments in international law related to both earth and space rescue services are examined. Upon analysis it becomes apparent that contemporary international standards for rescue of astronauts in outer space are inadequate and a number of provisions are enumerated as desirable for inclusion as amendments to the 1968 Agreement on the Rescue of Astronauts, the Return of Astronauts and the Return of Objects Launched into Outer Space in order to achieve a truly comprehensive convention on rescue and return of astronauts both on earth and in outer space.

Hermann, A. M.

ELECTRONIC PROPERTIES OF SOME TCNQ COMPLEXES
Rembaum, A., Hermann, A. M., Stewart, F. E., Gutmann, F.
The Journal of Physical Chemistry, Vol. 73, No. 3,
March 1969, pp. 513–520

For abstract, see Rembaum, A.

Holstrom, G. B.

LUNAR MASCONS: A NEAR-SURFACE INTERPRETATION

Conel, J. E., Holstrom, G. B.
Science, Vol. 162, December 20, 1968, pp. 1403–1405

For abstract, see Conel, J. E.

Hurd, W. J.

SPACECRAFT DEMONSTRATION OF SEQUENTIAL DECODING USING *LUNAR ORBITER V*

Hurd, W. J.
IEEE Transactions on Information Theory, Vol. IT 14, No. 5,
September 1968, pp. 761–765

The performance of a sequential decoder on data transmitted on a spacecraft link was demonstrated on February 26, 1968, culminating a series of experiments utilizing *Lunar Orbiter V* and the Deep Space Network Echo station. It demonstrated that sequential decoding can perform on a spacecraft link as well as was predicted by theoretical results and laboratory experiments. Performance is significantly better than that of practical block codes. For example, an erasure probability of 10^{-4} can be attained using sequential decoding with 2 dB less signal-to-noise ratio than required to attain an error probability of 10^{-4} using a (32,6) biorthogonal code and maximum-likelihood decoding.

Ingham, J. D.

FREE-RADICAL SPIN LABELS FOR MACROMOLECULES

Ingham, J. D.
Journal of Macromolecular Science—Reviews in Macromolecular Chemistry, Vol. C2, No. 2, 1968,
pp. 279–302

No abstract available.

Jaffe, L. D.

SURVEYOR VI LUNAR MISSION

Jaffe, L. D.
Journal of Geophysical Research, Vol. 73, No. 16,
August 15, 1968, pp. 5297–5300

Surveyor VI landed near a mare ridge in Sinus Medii November 7, 1967. It carried an alpha-particle backscattering instrument and a television camera. Data were obtained on the following properties of the lunar surface: topography, chemical composition, content of magnetic material, radar reflectivity, density, bearing capacity, modulus of rigidity, adhesion, albedo, photometric function, optical polarization, temperature, and thermal inertia. In general, the surface was strikingly similar to the mare sites where earlier *Surveyors* had landed. The surface layer of weakly cohesive particles is,

however, probably deeper than in Oceanus Procellarum or Mare Tranquillitatis. A number of measurements were made of the velocity of the landing site relative to earth. Observations of the sun showed that the F corona extends out at least 30 solar radii.

SCIENTIFIC RESULTS OF THE *SURVEYOR I* LUNAR LANDING

Jaffe, L. D.
Moon and Planets II, North-Holland Publishing Co.,
Amsterdam.
(Presented to COSPAR, London, England, July 1967,
pp. 91–118)

Surveyor I landed in a mare area, about 100 m from a crater 170 m in diameter. The surface at this site consists mostly of discrete particles smaller than 100 microns. The bearing strength of this material is about 3×10^{5} dyne/cm², the cohesion is between 10^{2} and 10^{5} dyne/cm². The granular layer is at least 1 m deep. Rocks in sizes up to a meter or more are abundant; many of them concentrated along crater rims. Some of these rock concentrations are apparently associated with local increases in radar cross-section at 2-cm wavelength. The thermal and electromagnetic properties at the landing site, on a scale of a few meters, and the photometric function, on a scale down to millimeters, are similar to the gross properties of the entire lunar disk; thus, a surface layer basically similar to that at the *Surveyor I* site presumably covers much of the moon.

Jaffe, P.

ANGLE-OF-ATTACK MOTION OF A SPINNING ENTRY VEHICLE

Prislin, R. H., Jaffe, P.
Journal of Spacecraft and Rockets, Vol. 6, No. 1,
January 1969, pp. 93–96

For abstract, see Prislin, R. H.

King, J.

SOIL TOXICITY IN ANTARCTIC DRY VALLEYS

Cameron, R. E., David, C. N., King, J.
Antarctic Journal of the United States, Vol. 3, No. 5,
September–October 1968, pp. 164–165

For abstract, see Cameron, R. E.

SOIL MICROBIAL AND ECOLOGICAL STUDIES IN SOUTHERN VICTORIA LAND

Cameron, R. E., King, J., David, C. N.
Antarctic Journal of the United States, Vol. 3, No. 4,
July–August 1968, pp. 121–123

For abstract, see Cameron, R. E.

King, J., Jr.

KINETIC ANALYSIS OF THE ION–MOLECULE REACTIONS IN NITROGEN–HYDROGEN MIXTURES USING ION CYCLOTRON RESONANCE

Bowers, M. T. (University of California)
Elleman, D. D., King, J., Jr. (Jet Propulsion Laboratory)

For abstract, see Bowers, M. T.

Kliore, A.

MARINER 5 AND THE RADIUS OF VENUS

Kliore, A., Cain, D. L.

The precise radio tracking of the *Mariner V* spacecraft has enabled the distance from the center of Venus of the line-of-sight joining the tracking station and the spacecraft to be determined with an uncertainty of less than 0.2 km near the time of occultation. The resulting profiles of temperature and pressure, when superimposed on the data of *Venera 4,* indicate that the Soviet probe penetrated to a radial distance of about 6079 km from the center of mass of Venus. If this is assumed to be the radius of the solid surface of Venus, it is at variance with the results of earth-based planetary radar studies. Extrapolation to the radar radius leads to atmospheric models that are consistent with the results of passive radio astronomy. It is concluded that the *Venera 4* probe either landed on a high plateau or surface feature undetected by radar, or did not continue its measurements to the surface of Venus.

RADIO OCCULTATION MEASUREMENTS OF THE ATMOSPHERES OF MARS AND VENUS

Kliore, A.

Radio occultation techniques provide convenient means for gathering information on planetary atmospheres by observing the effects of their refractivity on the propagation of radio signals from spacecraft travelling on trajectories which allow occultations.

An experiment carried out during the flight of *Mariner IV* made use of the measurements of the effects of the atmosphere and ionosphere of Mars on the S-band (2.3 GHz) tracking signal of the spacecraft to successfully obtain estimates of the surface pressure, composition, and vertical density profile in the atmosphere of Mars.

A similar experiment was planned for the flight of the *Mariner V* spacecraft to Venus in 1967. Because of the dense atmosphere of Venus, problems were expected which were not encountered during the Mars experiment. Results of model computations showed that refractive bending angles could exceed 25 deg, and defocusing attenuation of over 25 dB could be experienced in some of the high-pressure models having surface pressures of 100 earth atm. Although the trajectory and antenna of *Mariner V* were designed to counteract these effects, under such conditions the radio beam would have been unable to penetrate to the surface of the planet. The low density atmospheres that were studied (5 atm surface pressure) did not present this problem, indicating that surface measurements could be obtained. The computations also showed that while in most cases different compositions yielded different results, it is possible to arrive at two different compositions of almost identical molecular weights and refractivities, which yield very similar occultation results.

Kuppermann, A.

ANGULAR DEPENDENCE OF LOW-ENERGY EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H_2

Trajmar, S., Brinkmann, R. T. (Jet Propulsion Laboratory)
Rice, J. K., Kuppermann, A.
(California Institute of Technology)
Cartwright, D. C. (Institute for Extraterrestrial Physics)

For abstract, see Trajmar, S.

Laue, E. G.

SOLAR CONSTANT: FIRST DIRECT MEASUREMENTS

Laue, E. G. (Jet Propulsion Laboratory)
Drummond, A. J. (Eppley Laboratory)

The solar constant was directly measured from an altitude of about 82 km — apparently the first such determination. The total solar intensity was 136.1 mW/cm² or 1.952 cal/cm²/min — about 2.5% less than Johnson's derived value. Energy in the ultraviolet and visible regions (for λ less than 607 nm) was 7.0% less than that obtained by integration over Johnson's curve; for integral flux of λ greater than 607 nm there was almost perfect agreement. Seven supporting series of measurements from lower altitudes agreed extremely well with these results after correction for atmospheric extinction.

Lawson, D. D.

CHARACTERIZATION OF THE DIASTEREOMERS OF 2,4,-DIMETHYL-3-OXAPENTANE-1,5-DIOL

Lawson, D. D.

The diastereomeric forms of the 2,4-dimethyl-3-oxapentane-1,5-diol diprimary dipropylene glycol have been synthesized

by two routes: reduction of the diethyl dilactate ester with lithium aluminum hydride; and replacement of chlorine by an acetoxy group on 1,5-dichloro-2,4-dimethyl-3-oxapentane. The diprimary glycol is then obtained by an ester interchange with methanol and diacetate ester. The glycol diastereomeric forms are readily purified by distillation and/or preparative gas chromatography.

Lewicki, G.

CURRENTS THROUGH THIN FILMS OF ALUMINUM NITRIDE

Lewicki, G. (Jet Propulsion Laboratory)
Mead, C. A. (California Institute of Technology)
Journal of the Physics and Chemistry of Solids, Vol. 29, 1968, pp. 1255–1267

The current-voltage characteristics of thin film structures consisting of two metal electrodes separated by a thin insulating layer of AlN were measured as a function of insulator thickness. In thinner structures, the dependence of the current on voltage and insulator thickness was that expected from direct electron tunneling through a trapezoidal barrier. The characteristics were used to determine the barrier energies at the metal insulator interfaces and the energy-momentum relationship over a considerable portion of the AlN forbidden energy gap. In structures with thicker insulating regions, temperature-independent currents were observed which, because of their dependence on voltage and insulator thickness, could not be attributed to direct electron tunneling.

Lieske, J. H.

ICARUS AND THE DETERMINATION OF ASTRONOMICAL CONSTANTS

Lieske, J. H., Null, G. W.
Astronomical Journal, Vol. 74, No. 2, March 1969, pp. 297–307

Radar and optical observations of the minor planet Icarus (1566) have been analyzed in an attempt to verify the predictions of general relativity using both the Schwarzschild nonisotropic and isotropic metrics, and to estimate the dynamical oblateness of the sun, the mass of Mercury, and other parameters. Identical values of the relativity parameters λ_S and λ_I, which are introduced as multipliers of the relativistic effects due to Schwarzschild nonisotropic and isotropic line elements, respectively, were obtained if the elements of both the earth and Icarus were adjusted. A value of $\lambda_S = 1$ corresponds to motion in general relativity with the nonisotropic Schwarzschild line element, while $\lambda_I = 1$ corresponds to motion with the isotropic line element. The values $\lambda_S = \lambda_I = 0$ correspond to Newtonian motion. Values of λ_S were obtained over the interval $0.87 \pm 0.08 \le \lambda_S \le 1.26 \pm 0.11$. The nonuniform distribution of observations over the orbits of Icarus and the earth seriously affects the suitability of the Icarus data in verifying general relativity. The estimate of the dynamical oblateness of the sun is $J_2 = (1.8 \pm 2.0) \times 10^{-5}$

and the estimated mass of Mercury is $m_{\mathfrak{Q}}^{-1} = 5,934,000 \pm 65,000$. All error estimates are expressed in terms of the standard deviation (mean error) estimated from the data.

Loomis, A. A.

A LUNAR AND PLANETARY PETROGRAPHIC MICROSCOPE

Loomis, A. A.
The American Mineralogist, Vol. 53, September–October 1968, pp. 1724–1734

An engineering prototype model of a petrographic microscope for lunar and planetary missions has been designed and fabricated. It is designed primarily for remote operation on soft-landing spacecraft, but it could be adapted for support of a manned mission. An aggregate of crushed rock particles is thermally encapsulated between two opposing sheets of a clear isotropic thermoplastic which has a refractive index of 1.54. The images are projected through refracting lenses and an eyepiece onto the faceplate of a television camera. A television picture is taken both below and above the plane of correct focus as well as in that plane for each field of view in order to change the Becke line positions. Each particle is viewed in both plane-polarized and cross-polarized light; the spectral width through an interference filter is small enough to provide light and dark interference rings on a black-and-white television.

Lucas, J. W.

LUNAR SURFACE THERMAL CHARACTERISTICS DURING ECLIPSE FROM *SURVEYORS III, V* AND AFTER SUNSET FROM *SURVEYOR V*

Vitkus, G., Lucas, J. W., Saari, J. M.
AIAA 3rd Thermophysics Conference, Los Angeles, California, June 24–26, 1968. AAIA Paper No. 68-747, pp. 1–7

For abstract, see Vitkus, G.

Lyttleton, R. A.

ON THE DISTRIBUTION OF MAJOR-AXES OF LONG-PERIOD COMETS

Lyttleton, R. A.
Monthly Notices of the Royal Astronomical Society, Vol. 139, No. 2, 1968, pp. 225–230

The changes of value of the binding-energy for long-period comets through planetary action are such that the values of $1/a$ for their initial approach to the sun cannot be known. As the present values are to a less extent also subject to error, a plot of numbers of comets in successive small intervals of $1/a$ can reveal nothing concerning their origin. Even were such a plot accurately obtainable, it can be proved that no distribution exists possessing a maximum at some value of $1/a$ that converts into a distribution having a maximum at the corresponding value of a itself. These two considerations remove any basis for the claim that there exists a shell of

comets at great distance from the sun. A plot of numbers of comets against a exhibits no evidence of any congestion of aphelion-points at such distances.

ON THE ORIGIN OF TEKTITES
Lyttleton, R. A.
Geophysical Journal—Royal Astronomical Society, Vol. 15, 1968, pp. 191–204

The properties of tektites as yet afford little direct evidence of the source of their material and process of formation, but their forms strongly suggest that they arrive through the high atmosphere at low cosmic speeds. Their ages indicate a frequency of production of tektite fields of 10^6–10^7 years and this would be consistent with some rare catastrophic event such as cometary encounter or a large meteoritic impact. Immediate formation of tektites by such processes seems not to be possible, but for encounter with a cometary dust-cloud an accretion stream could result and tektites form secondarily within this. Similarly, a sufficiently large meteorite impacting the earth could result in the ejection of material far beyond the atmosphere, and this material condensed into fine particles moving in elliptic orbits surrounding the earth could form an accretion stream depositing tektites in the antipodal regions of the planet. This last hypothesis seems the most hopeful if a terrestrial origin of the material proves essential, since it would also meet the requirement of final entry of the tektites through the high atmosphere.

Manring, E. R.
MINIMUM DETECTABLE LIMIT OF LITHIUM IN THE UPPER ATMOSPHERE
Gardner, J. A., Manring, E. R., Patty, R. R.
AIAA Journal, Vol. 6, No. 10, October 1968, pp. 1997–2000

For abstract, see Gardner, J.A.

Margolis, J. S.
INFRARED ABSORPTION SPECTRUM OF CH_4 AT 9050 cm^{-1}
Margolis, J. S., Fox, K.
The Journal of Chemical Physics, Vol. 49, No. 5, September 1, 1968, pp. 2451–2452

The R branch of the second overtone of the fundamental ν_3 of methane has been investigated at high resolution in absorption at 9050 cm^{-1}. Accurate line positions have been obtained for the components of the J-manifolds $R(0)$ through $R(7)$. The dominant approximation of Hecht has been used to satisfactorily assign quantum numbers to the components.

Marshall, R. R.
LEAD–LEAD AGE OF THE BONDOC METEORITE
Marshall, R. R.
Geochimica et Cosmochimica Acta, Vol. 32, 1968, pp. 1013–1018

The concentration of lead in a portion of the Bondoc meteorite was determined by the isotopic dilution technique to be 0.071 ± 0.005 parts/10^6. Isotopic ratios of the lead in the meteorite were found to be $Pb^{206}/Pb^{204} = 20.11$, $Pb^{207}/Pb^{204} = 18.53$, and $Pb^{208}/Pb^{204} = 39.12$. The Pb^{207}/Pb^{204} ratio is quite high relative to the Pb^{206}/Pb^{204} ratio, indicating a possible lead–lead age of 4.94×10^9 years. This calculation is based on the assumption that the present U^{238}/U^{235} ratio in this meteorite is 137.7.

Masek, T. D.
THRUST SYSTEM TECHNOLOGY FOR SOLAR ELECTRIC PROPULSION
Masek, T. D., Pawlik, E. V.
AIAA 4th Propulsion Joint Specialist Conference, Cleveland, Ohio, June 10–14, 1968. AIAA Paper No. 68-541, pp. 1–16

Solar electric thrust system technology is reviewed. An experimental study, concerning: (1) influence of geometry and operating conditions on thruster performance, (2) accelerator grid performance, (3) electromagnet-permanent magnet tradeoffs, (4) hollow cathode operation with variable thruster power level, (5) control requiremènts and methods, and (6) power matching with the associated performance penalties, is described and correlated with development programs in other laboratories. Total efficiencies of 67% at 3500 s and 76% at 4000 s are obtained in a 2.5-kW thruster (including 2% power and 2% utilization corrections for the neutralizer). Operation with electromagnets or permanent magnets is shown to be equivalent. Thruster control system stability problems, arising from improved performance, are described and the methods for solution are presented. Of the two methods of power matching studied (constant specific impulse with variable propellant flow and beam current, and variable specific impulse with constant beam current), the constant specific impulse method appears to produce the least performance degradation. In addition, power conditioning, switching (between thrusters and power conditioners), and switching logic are discussed.

Mead, C. A.
CURRENTS THROUGH THIN FILMS OF ALUMINUM NITRIDE
Lewicki, G. (Jet Propulsion Laboratory)
Mead, C. A. (California Institute of Technology)
Journal of the Physics and Chemistry of Solids, Vol. 29, 1968, pp. 1255–1267

For abstract, see Lewicki, G.

Melbourne, W. G.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M., Melbourne, W. G., O'Handley, D. A., Pease, G. E., Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6, November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

RADAR DETERMINATION OF RADIUS OF VENUS

Melbourne, W. G., Muhleman, D. O., O'Handley, D. A.
Science, Vol. 160, May 31, 1968, pp. 987–989

The radius of Venus has been determined from radar-range data taken at the Goldstone Deep Space Communication Complex. A simultaneous integration of the equations of motion of the solar-system fit to this time-delay data gave a value of 6053.7 ± 2.2 km. Other determinations of the radius of Venus are discussed.

Metzger, A. E.

X-RAY EMISSION FROM CYGNUS XR-1

Metzger, A. E., Dolan, J. F.
The Astronomical Journal, Vol. 73, No. 5, Part II, June 1968 (Supplement)

A balloon flight launched from Page, Arizona, on January 15, 1968 observed the discrete X-ray source Cygnus XR-1 from a height of 132,000 ft (2.8 g/cm² residual atmosphere). Observations were made with a xenon-filled proportional counter actively shielded from the charged-particle-caused background by scintillating plastic. The detector was collimated so that Cygnus XR-3 was not in its field of view.

Comparison of these results for the integral flux of Cygnus XR-1 between 20 and 35 keV with previous observations extending back 3 yr provides an X-ray "light curve" indicating that Cygnus XR-1 is an eclipsing binary type of X-ray source with a period of 9–10 mo between primary minima. It is suggested that the binary may be composed of a starlike X-ray source, a non X-radiating companion star, and a high temperature gaseous envelope surrounding the pair that is also an X-ray source.

Misselhorn, J. E.

INSTABILITY OF HIGH-DRAG PLANETARY ENTRY VEHICLES AT SUBSONIC SPEEDS

Shirley, D. L., Misselhorn, J. E.
Journal of Spacecraft and Rockets, Vol. 5, No. 10, October 1968, pp. 1165–1169

For abstract, see Shirley, D. L.

Muhleman, D. O.

RADAR DETERMINATION OF RADIUS OF VENUS

Melbourne, W. G., Muhleman, D. O., O'Handley, D. A.
Science, Vol. 160, May 31, 1968, pp. 987–989

For abstract, see Melbourne, W. G.

Mulás, P.

DEGRADATION OF THE TIME CHARACTERISTICS OF SURFACE BARRIER DETECTORS WITH FISSION FRAGMENT DOSE

Mulás, P. (Instituto Politecnico Nacional, Mexico)
Haines, E. L. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 40. No. 3, March 1969, pp. 507–509

The effects of fission-fragment radiation damage on surface barrier particle detectors were investigated. It has been learned that the time required to collect a charge from the detectors may be inadequate because of radiation damage, even when the damage is too little to cause any loss of the charge through recombination effects.

Null, G. W.

ICARUS AND THE DETERMINATION OF ASTRONOMICAL CONSTANTS

Lieske, J. H., Null, G. W.
Astronomical Journal, Vol. 74, No. 2, March 1969, pp. 297–307

For abstract, see Lieske, J. H.

O'Handley, D. A.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M., Melbourne, W. G., O'Handley, D. A., Pease, G. E., Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6, November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

RADAR DETERMINATION OF RADIUS OF VENUS

Melbourne, W. G., Muhleman, D. O., O'Handley, D. A.
Science, Vol. 160, May 31, 1968, pp. 987–989

For abstract, see Melbourne, W. G.

Ozier, I.

THEORY OF THE COLLISION-INDUCED ROTATIONAL SPECTRUM OF TETRAHEDRAL MOLECULES

Ozier, I. (North American Rockwell Corporation)
Fox, K. (Jet Propulsion Laboratory)
Physics Letters, Vol. 27A, No. 5, July 15, 1968, pp. 274–275

For tetrahedral molecules, there is developed a quantum mechanical theory which relates the octopole moment to the integrated absorption of the collision-induced rotational spectrum. The theory is applied to recent far-infrared data on CH_4, CD_4 and CF_4.

Parker, R. H.

TESTING MODELS ON COMPRESSED SPECTRAL DATA

Haines, E. L., Parker, R. H. (Jet Propulsion Laboratory)
Gouw, R. (Informatics, Inc.)
Nuclear Instruments and Methods, Vol. 69, No. 1,
March 1, 1969, pp. 11–20

For abstract, see Haines, E. L.

Patty, R. R.

MINIMUM DETECTABLE LIMIT OF LITHIUM IN THE UPPER ATMOSPHERE

Gardner, J. A., Manring, E. R., Patty, R. R.
AIAA Journal, Vol. 6, No. 10, October 1968,
pp. 1997–2000

For abstract, see Gardner, J.A.

Pawlik, E. V.

THRUST SYSTEM TECHNOLOGY FOR SOLAR ELECTRIC PROPULSION

Masek, T. D., Pawlik, E. V.
AIAA 4th Propulsion Joint Specialist Conference,
Cleveland, Ohio, June 10–14, 1968. AIAA Paper No.
68-541, pp. 1–16

For abstract, see Masek, T. D.

Pease, G. E.

MASS, DYNAMICAL OBLATENESS, AND POSITION OF VENUS AS DETERMINED BY MARINER V TRACKING DATA

Anderson, J. D., Efron, L., Pease, G. E.
The Astronomical Journal, Vol. 73, No. 10, Part II
December 1968 (Supplement)

For abstract, see Anderson, J. D.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M.,
Melbourne, W. G., O'Handley, D. A., Pease, G. E.,
Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6
November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

Perlman, M.

THE SYNTHESIS OF BINARY SEQUENCE DETECTORS

Perlman, M.
IEEE Transactions on Computers, Vol C-17, No. 9,
September 1968, pp. 873–880

A method is presented for synthesizing a sequential network for detecting a given n-place nonperiodic binary sequence within a data stream. The n-place nonperiodic sequence is characterized as a binary (n, r) ring sequence. The state assignment for r 2-state memory elements is determined from an ordered set of n distinct subsequences r bits in length. The minimization of r simultaneous Boolean functions of $r + 1$ variables yields a representation of internal combinational logic in two-level form.

Poynter, R. L.

IMPROVED SWEEP MODULATOR FOR HIGH dc VOLTAGES

Remeikes, A., Beaudet, R. A. (University of
Southern California)
Poynter, R. L., Steffensen, G. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 39,
No. 8, August 1968, pp. 1223–1224

No abstract available.

PREDICTIONS OF SEVERAL OH Λ DOUBLING TRANSITIONS SUITABLE FOR RADIO ASTRONOMY

Poynter, R. L. (Jet Propulsion Laboratory)
Beaudet, R. A. (University of Southern
California)
Physical Review Letters, Vol. 21, No. 5, July 29, 1968,
pp. 305–308

No abstract available.

Prislin, R. H.

ANGLE-OF-ATTACK MOTION OF A SPINNING ENTRY VEHICLE

Prislin, R. H., Jaffe, R.
Journal of Spacecraft and Rockets, Vol. 6, No. 1,
January 1969, pp. 93–96

A closed form solution for the angular motion of a spinning entry vehicle is presented. The influence and interaction of the density gradient, the spin, the initial angles and angular rates, and the vehicle aerodynamics are demonstrated by the solution. It is shown that a spinning body with little or no transverse angular velocity will exhibit damped circular motion during entry. The effect of spin is to decrease the influence of the dynamic pressure gradient and increase the influence of the aerodynamic stability near peak deceleration. Examples are presented and comparisons are made with six-degree-of-freedom calculations; in all cases the angle-of-attack agreed with the theory to better than 5%.

Rembaum, A.

ELECTRONIC PROPERTIES OF SOME TCNQ COMPLEXES

Rembaum, A., Hermann, A. M., Stewart, F. E., Gutmann, F.
The Journal of Physical Chemistry, Vol. 73, No. 3,
March 1969, pp. 513–520

A study of electrical properties of tetracyanoquinodimethane (TCNQ) complexes representing unit segments of nonconjugated as well as conjugated polymers is described. Corresponding studies with the analogous polymer complexes are presented. The model compounds chosen were a saturated donor 1,2-bis(4-pyridyl)-ethane and an unsaturated donor 1,2-bis(4-pyridyl)ethylene. Analyses are presented to substantiate the chemical structure and spectrophotometric data are in agreement with previous results. Electron spin resonance studies show the triplet nature of the complexes, and rotational anisotropy in compressed pellets demonstrates orientation of molecules or crystallites during compression. Electronic transport properties, including the first reported measurement of the Hall effect in TCNQ complexes, are described. These measurements (along with companion studies of conductivity and thermoelectric power) indicate concentration of carriers of several orders of magnitude below that of the unpaired spins. The transport data presented are interpreted in terms of band theory.

Remeikes, A.

IMPROVED SWEEP MODULATOR FOR HIGH dc VOLTAGES

Remeikes, A., Beaudet, R. A. (University of Southern California)
Poynter, R. L., Steffensen, G. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 39,
No. 8, August 1968, pp. 1223–1224

No abstract available.

Rice, J. K.

ANGULAR DEPENDENCE OF LOW-ENERGY EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H_2

Trajmar, S., Brinkmann, R. T. (Jet Propulsion Laboratory)
Rice, J. K., Kuppermann, A. (California Institute of Technology)
Cartwright, D. C. (Institute for Extraterrestrial Physics)
The Journal of Chemical Physics, Vol. 49, No. 12,
December 15, 1968, pp. 5464–5472

For abstract, see Trajmar, S.

Rusch, W. V. T.

OBSERVATIONS OF THE TOTAL LUNAR ECLIPSE OF OCTOBER 18, 1967, AT A WAVELENGTH OF 3.33 MILLIMETERS

Rusch, W. V. T., Slobin, S. D. (University of Southern California)

Stelzried, C. T., Sato, T. (Jet Propulsion Laboratory)
The Astrophysical Journal, Vol. 155, March 1969,
pp. 1017–1021

On October 18, 1967, radiometric observations of a total lunar eclipse were carried out at a wavelength of 3.33 mm from the Goldstone Deep Space Communications Complex in the Mojave Desert of California. A decrease of 7% in the equivalent black-body disk temperature of the moon was measured during the eclipse. The 1σ error is estimated to be 0.33% of the moon's temperature. Based on an equivalent black-body disk temperature of the full moon of 280°K, this 7% decrease amounts to a temperature decrease of $[19.6 \pm 0.9 \ (1\sigma)]$°K.

Russell, D. A.

DENSITY DISTURBANCE AHEAD OF A SPHERE IN RAREFIED SUPERSONIC FLOW

Russell, D. A.
The Physics of Fluids, Vol. 11, No. 8,
August 1968, pp. 1679–1685

An electron-beam X-ray technique was used to obtain precise measurements of the density along the stagnation streamline of spherical models tested in a M = 4.2 (nominal Mach number) nitrogen stream and a M = 3.8 argon stream. Variation of the total pressure and the model radius provided a Re range (based on free-stream properties and model radius) of 30–500 in nitrogen, 100–2000 in argon. The measurements were made with model surface temperatures of 300° K (equal to the total temperature of the flow) and 78° K.

Saari, J. M.

LUNAR SURFACE THERMAL CHARACTERISTICS DURING ECLIPSE FROM SURVEYORS III, V AND AFTER SUNSET FROM SURVEYOR V

Vitkus, G., Lucas, J. W., Saari, J. M.
AIAA 3rd Thermophysics Conference, Los Angeles,
California, June 24–26, 1968. AIAA Paper No. 68-747,
pp. 1–7

For abstract, see Vitkus, G.

Sato, T.

OBSERVATIONS OF THE TOTAL LUNAR ECLIPSE OF OCTOBER 18, 1967, AT A WAVELENGTH OF 3.33 MILLIMETERS

Rusch, W. V. T., Slobin, S. D. (University of Southern California)
Stelzried, C. T., Sato, T. (Jet Propulsion Laboratory)
The Astrophysical Journal, Vol. 155, March 1969,
pp. 1017–1021

For abstract, see Rusch, W. V. T.

Shirley, D. L.

INSTABILITY OF HIGH-DRAG PLANETARY ENTRY VEHICLES AT SUBSONIC SPEEDS

Shirley, D. L., Misselhorn, J. E.
Journal of Spacecraft and Rockets, Vol. 5, No. 10,
October 1968, pp. 1165–1169

A marked divergence in the subsonic angle-of-attack en-velope of a rolling, 60 deg half-angle, spherically blunted cone entry vehicle has been observed in the simulation of Venus and Mars entry trajectories by six- and four-degree-of-freedom computer programs. The divergence is related to the vehicle characteristics such as moments of inertia and aerodynamic coefficients (particularly the dynamic stability coefficient), to the roll rate, and to the trajectory and plane-tary factors such as dynamic pressure gradient and gravita-tional acceleration. Criteria are presented which satisfactorily predict the computed angle-of-attack variation. Experimental programs are recommended to check predicted angle-of-attack behavior since the divergence is sensitive to small variations in the dynamic stability coefficients.

Shulman, G. P.

THERMAL DECOMPOSITION OF AROMATIC AND HETEROAROMATIC AMINO-ACIDS

Shulman, G. P., Simmonds, P. G.
Chemical Communications, No. 17, 1968, p. 1040

Gas chromatography–mass spectrometry of the pyrolysates from phenylalanine, tyrosine, tryptophane, and histidine shows that the thermal degradation of these amino acids proceeds by similar pathways involving decarboxylation and/or de-amination.

Shumka, A.

A GERMANIUM SOLID-STATE TRIODE

Shumka, A.
Journal of Applied Physics, Vol. 40, No. 1, January 1969,
pp. 438–439

An experimental solid-state triode that is directly analogous to a vacuum-tube triode is described. Control and modula-tion of space-charge-limited electron currents have been achieved by inserting a control electrode into an $n^+\pi n^+$ ger-manium solid-state diode. A family of V–I curves as a func-tion of the control voltage is shown for one of the solid-state triodes.

Simmonds, P. G.

THERMAL DECOMPOSITION OF AROMATIC AND HETEROAROMATIC AMINO-ACIDS

Shulman, G. P., Simmonds, P. G.
Chemical Communications, No. 17, 1968, p. 1040

For abstract, see Shulman, G. P.

Slobin, S. D.

OBSERVATIONS OF THE TOTAL LUNAR ECLIPSE OF OCTOBER 18, 1967, AT A WAVELENGTH OF 3.33 MILLIMETERS

Rusch, W. V. T., Slobin, S. D. (University of
Southern California)
Stelzried, C. T., Sato, T. (Jet Propulsion Laboratory)
The Astrophysical Journal, Vol. 155, March 1969,
pp. 1017–1021

For abstract, see Rusch, W. V. T.

Smith, E. J.

PLANETARY MAGNETIC FIELD EXPERIMENTS

Smith, E. J.
*Advances in the Astronautical Sciences, 1969: Vol. 25,
Advanced Space Experiments,* pp. 103–130

Magnetic field measurements in the vicinity of Venus, Mars and the moon have shown that earth's nearest neighbors are magnetized weakly, if at all. None of them show a magnetic dipole moment any larger than 0.30% of the earth's moment, results which are consistent with present knowledge concerning the origin of planetary magnetism and the interiors of these bodies. In spite of the apparent absence of a planetary field, the interactions of the solar wind (which are distinctly dif-ferent for the earth, the moon and Venus) have significant implications for solar–planetary relations and for the physics of collisionless plasmas. Future planetary missions will un-doubtedly include magnetic field experiments.

Steffensen, G.

IMPROVED SWEEP MODULATOR FOR HIGH dc VOLTAGES

Remeikes, A., Beaudet, R. A. (University of
Southern California)
Poynter, R. L., Steffensen, G. (Jet Propulsion Laboratory)
The Review of Scientific Instruments, Vol. 39,
No. 8, August 1968, pp. 1223–1224

No abstract available.

Stelzried, C. T.

OBSERVATIONS OF THE TOTAL LUNAR ECLIPSE OF OCTOBER 18, 1967, AT A WAVELENGTH OF 3.33 MILLIMETERS

Rusch, W. V. T., Slobin, S. D. (University of
Southern California)
Stelzried, C. T., Sato, T. (Jet Propulsion Laboratory)
The Astrophysical Journal, Vol. 155, March 1969,
pp. 1017–1021

For abstract, see Rusch, W. V. T.

MICROWAVE THERMAL NOISE STANDARDS

Stelzried, C. T.
IEEE Transactions on Microwave Theory and Techniques,
Vol. MTT-16, No. 9, September 1968, pp. 646–655

Calibrated microwave thermal noise standards usually consist of a matched resistive element thermally isolated by a transmission line. They are used for microwave radiometry, antenna temperature calibrations, loss measurements, low-noise amplifier performance evaluation, and low-level cw signal level calibrations. The formula used to account for the distributed loss and temperature along the transmission line is derived and simplifying approximations and limitations are noted. Exact $(hf/kT \ll 1)$ and approximate $(hf/kT \ll 1, \mathcal{L} \ll 1)$ solutions for various loss and temperature distributions are tabulated. A Fortran computer program is available for a general solution that uses the transmission-line temperature and loss distributions for input data. The single largest source of calibration error is usually the microwave insertion loss measurements. The construction, calibration, and errors are discussed for a field-operational liquid-nitrogen-cooled waveguide noise standard. This standard is precisely calibrated and has a nominal noise temperature of $\langle 78.09 \pm 0.12 \rangle$ °K peak.

Stewart, F. E.

ELECTRONIC PROPERTIES OF SOME TCNQ COMPLEXES

Rembaum, A., Hermann, A. M., Stewart, F. E., Gutmann, F.
The Journal of Physical Chemistry, Vol. 73, No. 3,
March 1969, pp. 513–520

For abstract, see Rembaum, A.

Tang, R.

THE MICROWAVE SPECTRA, MOLECULAR STRUCTURE, AND DIPOLE MOMENT OF PHOSPHIRANE

Bowers, M. T., Beaudet, R. A. (Jet Propulsion Laboratory)
Goldwhite, H. (University of Southern California)
Tang, R. (California State College at Los Angeles)
Journal of the American Chemical Society,
Vol. 91, No. 17, 1969, pp. 17–20

For abstract, see Bowers, M. T.

Tausworthe, R. C.

THE RADIUS OF VENUS AS DETERMINED BY PLANETARY RADAR AND MARINER 5 RADIO TRACKING DATA

Anderson, J. D., Cain, D. L., Efron, L., Goldstein, R. M.,
Melbourne, W. G., O'Handley, D. A., Pease, G. E.,
Tausworthe, R. C.
Journal of Atmospheric Sciences, Vol. 25, No. 6,
November 1968, pp. 1171–1173

For abstract, see Anderson, J. D.

Trajmar, S.

ANGULAR DEPENDENCE OF LOW-ENERGY EXCITATION CROSS SECTION OF THE LOWEST TRIPLET STATES OF H_2

Trajmar, S., Brinkmann, R. T. (Jet Propulsion Laboratory)
Rice, J. K., Kuppermann, A. (California Institute of Technology)
Cartwright, D. C. (Institute for Extraterrestrial Physics)
The Journal of Chemical Physics, Vol. 49, No. 12,
December 15, 1968, pp. 5464–5472

The differential cross-sections for the electron-impact excitation of the lowest triplet states of molecular hydrogen $(b \ ^3\Sigma_u^+, a \ ^3\Sigma_g^+)$ have been calculated from threshold to 85 eV impact energy using the Ochkur–Rudge theory. For the $X \ ^1\Sigma_g^+ \rightarrow b \ ^3\Sigma_u^+$ transition, the relative differential cross-sections were measured with a low-energy, high-resolution electron-impact spectrometer from 10 to 80 deg scattering angle and impact energies of 25, 35, 40, 50, and 60 eV. Theory and experiment are in good agreement for the shape of the differential cross-section for energies of 35 eV and above. However, at 25 eV, the theory continues to predict a rather well-developed maximum in the cross-section at around 40 deg while the experimental cross-sections are more isotropic. An appreciable contribution to the inelastic scattering in the energy loss region from 11 to 14 eV due to excitation to the $a \ ^3\Sigma_g^+$ and/or $c \ ^3\Pi_u$ states is definitely established from the observed angular distributions. A quantitative evaluation of the individual angular behavior of the excitations in this region, however, would require a resolution higher than the presently available one of 0.030 eV.

Turner, J. E.

GROUND-STATE ENERGY EIGENVALUES AND EIGENFUNCTIONS FOR AN ELECTRON IN AN ELECTRIC-DIPOLE FIELD

Turner, J. E., Anderson, V. E. (Oak Ridge National Laboratory)
Fox, K. (Jet Propulsion Laboratory)
Physical Review, Vol. 174, No. 1, October 5, 1968,
pp. 81–89

Ground-state energy eigenvalues and eigenfunctions are obtained by a variational method for an electron in the field of a finite, stationary, permanent electric dipole. The dipole moments studied cover the range from the minimum value required for binding $(D_{min} = 0.6393 \ ea_0)$ to $D = 400 \ ea_0$, where the system is equivalent to the hydrogen atom perturbed slightly by a distant stationary negative charge. The eigenvalues obtained agree with those previously reported by Wallis, Herman, and Milnes, who determined them by another method in the range $D = 0.84$ to $30 \ ea_0$. The normalized eigenfunctions display the manner in which the electronic charge density changes from that of the hydrogen atom at very large D to a flat distribution approaching that which is characteristic of a zero-energy continuum state as the

minimum moment is approached from above. Optimized variational wave functions for different values of D are presented for use in other calculations. Contour maps and profiles of electronic charge density are shown for a number of values of D. Mean values of the powers -1, 1, and 2 of the distances of the electron from the dipole charges are also calculated.

Unti, T.

TWO-DIMENSIONAL CHAPMAN-FERRARO PROBLEM WITH NEUTRAL SHEET
1. THE BOUNDARY
Unti, T., Atkinson, G.
Journal of Geophysical Research, Space Physics, Vol. 73, No. 23, December 1, 1968, pp. 7319–7327

An exact solution to a two-dimensional magnetosphere with tail and neutral sheet using the Chapman-Ferraro approximation has been found by mapping in the potential plane. The magnetic flux in the tail is an arbitrary parameter of the problem. Boundary and neutral sheet configurations are presented for several values of tail flux. It is found that the position of the neutral sheet and its return current on the outer boundary is very sensitive to the amount of magnetic flux in the tail. The relationship with the three-dimensional case is discussed, and it is concluded that the neutral sheet probably moves in and out by several earth radii. This suggests the following large-scale convective flow pattern for the magnetosphere. Between magnetospheric substorms, field lines are carried into the tail, which causes an increase in tail flux, an inward motion of the neutral sheet, and a two-celled ionospheric current system. The magnetospheric substorm then chops off the inner edge of the neutral sheet, returning the system to its initial topology.

Utku, S.

EXPLICIT EXPRESSIONS FOR TRIANGULAR TORUS ELEMENT STIFFNESS MATRIX
Utku, S.
AIAA Journal, Vol. 6, No. 6, June 1968, pp. 1174–1176

Although the use of triangular torus elements (or ring elements) in the analysis of solids of revolution has been previously reported, no explicit expression has been given for the stiffness matrix. This paper provides explicit expressions for the stiffness matrix of triangular torus elements associated with linear displacement fields and generalized Hookian material. It provides well-behaved finite element representation. The matrix is positive. One can use the matrix to solve equilibrium problems of solids of revolution undergoing small axisymmetric deformations. The convergence characteristics of the matrix are also demonstrated.

Vitkus, G.

LUNAR SURFACE THERMAL CHARACTERISTICS DURING ECLIPSE FROM SURVEYORS III, V AND AFTER SUNSET FROM SURVEYOR V
Vitkus, G., Lucas, J. W., Saari, J. M.

AIAA 3rd Thermophysics Conference, Los Angeles, California, June 24–26, 1968. AIAA Paper No. 68-747, pp. 1–7

Excellent temperature data were obtained from *Surveyors III* and *V* during a lunar eclipse and from *Surveyor V* during the extended period of two lunar nights. Lunar surface brightness temperatures were derived and the thermal parameter (γ) of lunar surface material was estimated from these temperature data. An effective γ of 500 cm^2 s$^{1/2}$ °K/gm-cal was estimated from the eclipse lunar surface cooling data for the *Surveyor III* site. The *Surveyor V* eclipse and post-sunset data indicate a γ of approximately 400. Previous earth-based telescopic measurements indicated a γ of 1370 for the landing site regions. Several possible explanations for these γ differences are discussed.

Wade, F. A.

PERMAFROST FEATURES ON THE MARTIAN SURFACE
Wade, F. A., de Wys, J. N.
ICARUS: International Journal of the Solar System, Vol. 9, No. 1, July 1968, pp. 175–185

Permanently frozen ground may be a distinct possibility in all latitudes on Mars. Mean shallow subsurface temperatures are below the freezing point of water. Given a supply of water, either meteoric or juvenile, minor topographic features will develop in permafrost areas. These features include patterned ground, or ridges and troughs arranged in polygonal patterns, and irregular mounds formed by frost heaving. Because of the probable absence of liquid water on the surface, any ice-saturated permafrost will have formed from water that has reached the surface zone from the interior during volcanism or outgassing. Sand wedges may develop in the permafrost because of the seasonal expansion and contraction of that zone with alternate penetrations of the heat and cold waves. With the growth of these wedges, patterned ground may develop on the surface. Any downward percolating water from the surface or hoar frost crystals forming in fractures could aid this process.

Wahlquist, H. D.

INTERIOR SOLUTION FOR A FINITE ROTATING BODY OF PERFECT FLUID
Wahlquist, H. D.
The Physical Review, Vol. 172, No. 5, August 25, 1968, pp. 1291–1296

An axially symmetric, stationary, type-D solution of Einstein's field equations has been found which represents the superposition of a Kerr-NUT metric and a rigidly rotating perfect fluid in the same space-time region, analogous to the Newtonian superposition of the gravitational fields of a mass point, or ring, and a surrounding body of distributed matter. A fairly large family of old and new metrics are thus included as special cases: Schwarzschild, NUT, and Kerr exterior solutions, and new interior solutions for a stationary body of fluid,

either spherical and nonrotating, or rigidly rotating with arbitrary angular velocity.

DYADIC ANALYSIS OF SPATIALLY HOMOGENEOUS WORLD MODELS
Estabrook, F. B., Wahlquist, H. D., Behr, C. G.
Journal of Mathematical Physics, Vol. 9, No. 4, April 1968, pp. 497–504

For abstract, see Estabrook, F. B.

Wang, C.-Y.

A NOTE ON THE DRAG OF AN IMPULSIVELY STARTED CIRCULAR CYLINDER
Wang, C.-Y.
Journal of Mathematics and Physics,
Vol. 47, No. 4, December 1968, pp. 451–455

In a previous paper by the author, the method of inner and outer expansions was used to obtain uniformly valid solutions for the flow field of an impulsively started circular cylinder. The effects of curvature were shown to be important at high Reynolds numbers. These effects are even more pronounced at low Reynolds numbers. A very interesting and important result from this method is the determination of the drag experienced by the cylinder. In this paper, the case is investigated where the Reynolds number $(U_\infty a/\nu)$ is of order unity.

Woo, R.

MULTIPACTING BREAKDOWN IN COAXIAL TRANSMISSION LINES
Woo, R.
Proceedings of the IEEE, Vol. 56, No. 4, April 1968, pp. 776–777

Multipacting breakdown data have been obtained in 50-Ω rigid coaxial transmission lines for frequencies above 150 MHz. The data show very good scaling correspondence with those obtained previously at frequencies below 150 MHz.

Wu, C.-S.

ENHANCED FLUCTUATIONS IN A MAGNETIZED PLASMA DUE TO A DEGENERATE ION-WAVE INSTABILITY
Wu, C.-S., Zmuidzinas, J. S.
Physical Review, Vol. 177, No. 1, January 5, 1969, pp. 408–412

A nondispersive low-frequency mode is shown to exist in a magnetized plasma with frequencies much lower than the ion cyclotron frequency. This may be viewed as a degenerate ion acoustic mode. The condition for its existence is that the longitudinal electron-to-ion temperature ratio be much greater than unity. In the presence of electron drift relative to the ions and parallel to the magnetic field, the plasma may become unstable if the drift speed exceeds a certain critical value. In the stable region, the electric field fluctuations can become greatly enhanced when the drift speed is close to the phase velocity of the wave. Since the wave is nondispersive, the enhancement occurs for a wide range of wave numbers.

UNIFIED QUASILINEAR THEORY OF WEAKLY TURBULENT PLASMAS
Wu, C.-S.
The Physics of Fluids, Vol. 11, No. 8, August 1968, pp. 1733–1744

A quasilinear theory is formulated which includes the microscopic fluctuation fields as well as the coherent waves. The study emphasizes those cases in which the propagating mode of the fluctuation field gives rise to a dominant contribution to the particle correlation. In other words, in these cases the spontaneous Čerenkov emission of plasmons can play a more important role than the two-particle collision process. The instability which is responsible for the turbulence can be of an electrostatic, electromagnetic, or a mixed nature. The effect of an external magnetic field is also considered in the present theory. The final result is valid for an arbitrary ratio of the energy density of the coherent wave to that of the fluctuation field although the condition of weak turbulence is imposed throughout the analysis.

Young, A. T.

AN UPPER LIMIT TO THE SURFACE PRESSURE OF VENUS
Young, A. T., Gray, L. D.
ICARUS: International Journal of the Solar System,
Vol. 9, No. 1, July 1968, pp. 74–81

An upper limit to the Venus surface pressure of 25 bars is obtained by combining a mechanical model of the atmosphere with an atmospheric model that reproduces the observed brightness temperature of the planet. It is also shown that carbon dioxide is not a minor constituent of the Venus atmosphere.

Zmuidzinas, J. S.

ENHANCED FLUCTUATIONS IN A MAGNETIZED PLASMA DUE TO A DEGENERATE ION-WAVE INSTABILITY
Wu, C.-S., Zmuidzinas, J. S.
Physical Review, Vol. 177, No. 1, January 5, 1969, pp. 408–412

For abstract, see Wu, C.-S.

Numerical Index

Technical Reports

Technical Report	Entry No.	Technical Report	Entry No.	Technical Report	Entry No.
32-255, Pt. V	R15	32-1290, Pt. I	M13	32-1339	M17
32-767	V02	32-1290, Pt. II	C03	32-1340	L07
32-809	B22	32-1291	G07	32-1341	K09
32-883	S18	32-1292	O03	32-1342	S09
32-997	E03	32-1293	C09	32-1343	G08
32-1165, Rev. I	B09	32-1294	R14	32-1344	B10
32-1177, Pt. III	S35	32-1296	O01	32-1345	O05
32-1177, Pt. III (Addendum)	R03	32-1297	M11	32-1346	K10
		32-1299	S10	32-1347	T08
32-1203, Vol. I	M02	32-1300	B06	32-1349	K12
32-1203, Vol. II	M03	32-1301	B02	32-1350	H11
32-1230	E01	32-1302	L02	32-1351, Pt. I	C05
32-1231, Rev. I	A03	32-1303	G06	32-1352	D04
32-1246, Pt. III	B13	32-1304	Y01	32-1353	F01
32-1256	W09	32-1305	P08	32-1354	T01
32-1258	P01	32-1305 (Addendum)	P09	32-1355	W02
32-1259	C06	32-1306	M09	32-1356	A05
32-1261	K15	32-1307	M16	32-1358	L05
32-1262, Pt. I	S36	32-1308	Z01	32-1359	Y03
32-1262, Pt. III	B14	32-1309	F02	32-1361	B08
32-1264, Pt. I	S37	32-1310	K01	32-1362	M12
32-1264, Pt. II	S38	32-1311	K03	32-1364	T05
32-1264, Pt. III	B15	32-1312	S05	32-1365	W06
32-1265, Pt. I, Vol. I	S39	32-1313	R11	32-1366	K07
32-1265, Pt. I, Vol. II	S39	32-1314	S01	32-1367	H05
32-1265, Pt. II	S40	32-1315	C04	32-1368	S13
32-1266	W11	32-1317	D06	32-1369	K06
32-1274	E04	32-1318	H02	32-1370	B16
32-1276	C11	32-1323	O04	32-1371	H03
32-1277	H04	32-1325	N01	32-1372	G05
32-1278	B01	32-1326	K08	32-1374	S22
32-1279	B23	32-1327	P03	32-1375	M05
32-1280	M06	32-1328	E05	32-1378	C01
32-1281	K11	32-1330	R08	32-1379	W10
32-1282	V01	32-1331	B18	32-1383	D08
32-1283	C08	32-1332	B03	32-1384	R07
32-1284	D09	32-1333	F04	32-1385	R13
32-1285	T03	32-1334	Y02	32-1387	L12
32-1286	B19	32-1335	B04	32-1389	F03
32-1288	L08	32-1336	S04	32-1398	G02
32-1289	P02	32-1337	O02	32-1399	S32
		32-1338	D10	32-1412	R02

Technical Memorandums

Technical Memorandum	Entry No.	Technical Memorandum	Entry No.	Technical Memorandum	Entry No.
33-239, Vol. III	R04	33-395	K16	33-405	B17
33-377	C12	33-396	L03	33-408	M15
33-382	J02	33-397	W12	33-409	K04
33-384	R09	33-398	P10	33-410	M01
33-387	P04	33-399	B05	33-411	L14
33-389	G03	33-400	W05	33-413	N02
33-390	D05	33-401	O06	33-414	L06
33-391	B11	33-402	J03	33-421	M04
33-392	P05	33-403	K13	33-424	N04
33-394	W03	33-404	K14	33-429	A04

Space Programs Summary

Space Programs Summary	Entry No.	Space Programs Summary	Entry No.	Space Programs Summary	Entry No.
37-50, Vol. III	AB03	37-52, Vol. III	AB03	37-54, Vol. III	AB03
37-51, Vol. I	AB01	37-53, Vol. I	AB01	37-55, Vol. I	AB01
37-51, Vol. II	AB02	37-53, Vol. II	AB02	37-55, Vol. II	AB02
37-51, Vol. III	AB03	37-53, Vol. III	AB03	37-55, Vol. III	AB03
37-52, Vol. I	AB01	37-54, Vol. I	AB01	37-56, Vol. I	AB01
37-52, Vol. II	AB02	37-54, Vol. II	AB02	37-56, Vol. II	AB02

Subject Index

Subject	Entry

Column 1:

Lunar Orbiter **Project** (contd)
gravity analysis L12
performance of breadboard elec-
tronics system developed for
gamma ray spectrometer M11
consistency of spacecraft
residuals with lunar trajectory
and local gravity effects........M16
mascons (lunar mass concentra-
tions), as revealed by
tracking data M17

Lunar Surface
photographs by *Surveyor*
spacecraft B13
B14
B15
R03
S35
S38
S40
geological characteristics, as
determined by spacecraft
photographic exploration H04
S32
mechanical, thermal, and elec-
tromagnetic properties, as
determined by *Surveyor*
spacecraft S38
S40

Management Systems
Mariner Venus 67 Project organiza-
tion and management controls...M02
Surveyor Project organization
and management controls S39

Mariner **Mars 1964 Project**
spacecraft disturbance torques
and limit cycles P08
P09
extended mission operations R04
Master Data Library R04
scientific experiments R04
S18

Mariner **Mars 1969 Project**
high-rate telemetry system
developed for 1969 missions.....T01

Mariner **Venus 67 Project**
electromagnetic compatibility
program C04
J03
temperature control subsystem.....D09
solar proton forecast system
and procedures used during
mission G06
mission description and
spacecraft performance M02
M03
project organization and
spacecraft development M02
extended mission operations M04

Column 2:

Mariner **Venus 67 Project** (contd)
dual-frequency receiver M05
power, attitude-control, and
central computer and
sequencer subsystems P01
spacecraft disturbance torques
and limit cycles P08
P09
failure rate analysis of
spacecraft data W11

Masers and Lasers
electron and laser beam welding
of spacecraft electronic parts....L03
laser beam pointing tests using
Surveyor VII spacecraft.........S38
S40

Materials, Nonmetallic
carbon deposition during tensile
creep tests of pyrolytic and
glassy carbons F02
basal-plane metallography of
deformed pyrolytic carbon F03
effects of various dry-heat
sterilization cycles on
polymeric materials K01
materials-design synthesis for
optimum design of impact
limiters K10

Mathematical Sciences
conservation equations of a
viscous, heat-conducting fluid
in curvilinear orthogonal
coordinates B03
matrix manipulations required
for common structural
analysis problems B05
error analysis for relative and
absolute orientation in the
general solution of a photo-
grammetric stereopair B10
highly convergent relaxation
method for inversion of full
radiative-transfer equation C05
mathematics used in calculating
circularly polarized patterns
of spacecraft erectable
high-gain antennas D04
error probabilities in telemetry
system using a squaring loop
to generate a coherent
subcarrier reference D06
algorithms used to develop com-
puter program for simplifying
incompletely specified sequen-
tial machines using Paull and
Unger technique E03
equations used in calculating
steady-state thrust and flow-
rate levels for attitude-control
nitrogen gas jets F01

Column 3:

Mathematical Sciences (contd)
numerical calculation of electron–
atom excitation and ionization
rates using Gryzinski cross
sections G05
transport equations for gases
and plasmas obtained by the
13-moment method H02
chemical equilibrium and com-
position equations developed
from statistical mechanics for
use in computing dynamic
properties of shock-tube gases...H11
path-finding algorithm for an
unmanned roving vehicle.......K06
L08
optimal nonlinear estimation based
on orthogonal expansions K07
mathematical formulation of
extremum problem associated
with the optimum design of
impact limiters and a semi-
geometric solution K10
effect of interference on error
probability for maximum-
likelihood receiver designed to
extract binary data from
message sequence in white
gaussian noise K11
receptance matrix of component
system with large parallel
parts of columns removed, for
use in obtaining accurate
receptance matrix of coupled
system near a component
resonance frequency L14
mathematical analysis of variations
in weight and performance
characteristics of large-area
solar arrays O02
mathematical analysis to provide
analytic basis for determining
key parameters and specifying
component tolerances for peak
detector and analog-to-
pulsewidth converter circuit O06
minimization algorithm having
aerospace system design
applications R13
polynomial smoothing formulas
and derivative formulas for one
or two independent variables....S05
derivation of working equations
and error analyses for JPL
active cavity radiometer and
angstrom pyrheliometer W06
bounding technique of first
excursion probability Y01
mathematical model of the
effect of a predator on
species diversity Y03

| Subject | Entry | Subject | Entry | Subject | Entry |

Subject	Entry	Subject	Entry	Subject	Entry

Planetary Spacecraft, Advanced
fuel-optimal retrothrust control problems for propulsive soft-landing maneuvers in the presence of drag B08
performance of Mars soft lander with staged propulsion K03
gravity-gradient effects on attitude-controlled planetary orbiter spacecraft K04
planetary orbiter autopilot.........K12
power system design for Jupiter solar–electric propulsion spacecraft T08

Planetary Surfaces
current theories for Jupiter, Saturn, Uranus, and Neptune....N04
pyrolysis–gas chromatography–mass spectrometry system for possible use in organic analysis of Martian soil S13

Plasma Physics
variable-velocity magnetohydro-dynamic induction generator with rotating-machine internal electrical efficiency E05
transport equations for gases and plasmas obtained by the 13-moment method H02
multistage liquid-metal magneto-hydrodynamic power conversion cycle H03
unified quasilinear theory of weakly turbulent plasmas W12

Power Sources
variable-velocity magnetohydro-dynamic induction generator with rotating-machine internal electrical efficiency E05
multistage liquid-metal magneto-hydrodynamic power conversion cycle H03
Mariner Venus 67 power subsystem M02
M03
P01
effects of environmental exposures on silicon solar cells...........M12
variations in weight and per-formance characteristics of large-area solar arrays..........O02
power matching of ion thruster to solar cell power output.........P05
sky effect on solar cells calibrated at 80,000 ft R11
parametric tests of thermoelectric generator SNAP 11 ....R14

Power Sources (contd)
Surveyor power subsystem S36
S37
S39
power system design for Jupiter solar–electric propulsion spacecraft T08

Propulsion, Liquid
spherical blast waves and detona-tion waves in a rocket combustion chamber B19
influence of several near-wall injection conditions on com-bustion performance of a liquid-rocket engine C08
destructive liquid-rocket resonant combustion C09
theory of laminar flames in stagnation flows K15
criteria for separation of impinging streams of hypergolic propellants K16
Mariner Venus 67 subsystem......M02
M03
evaluation of throttlable impinging-sheet injector with earth-storable propellants R08
influence of vanes on combustion and combustion stability R15
Surveyor low-thrust system S36
S37
S39

Propulsion, Nuclear–Electric
mercury electron-bombardment ion engine system.............M06
scaling of high-performance electron-bombardment ion thruster P04
power matching of ion thruster to solar cell power output.......P05
control system for in-core thermionic reactor W02

Propulsion, Solid
measurement of particle size of aluminum oxide produced by a small rocket motor..........D08
performance of a Mars soft lander with staged propulsion K03
Surveyor high-thrust system S36
S37
S39

Pyrotechnics
design of low-voltage capacitor-discharge circuits for firing squibs E01
Mariner Venus 67 pyrotechnic devices M02
M03

Pyrotechnics (contd)
Surveyor pyrotechnic devices S36
S37
S39

Quality Assurance and Reliability
reliability–confidence combinations for small-sample tests of aerospace ordnance items B09
quality assurance monitoring of microbiological aspects of JPL sterilization assembly development laboratory G02
Mariner Venus 67 quality assurance and reliability operations M02
Mariner V parts reliability results M03
W11
Surveyor quality assurance and reliability operations S39
bounding technique of first excursion probability, with its direct relationship to the reliability of mechanical and structural systems subjected to random external disturbances Y01

Quantum Theory and Relativity
statistical mechanics used to develop chemical equilibrium and composition equations H11

Radar
Surveyor altitude marking radar and radar altimeter and doppler velocity sensor S36
S37
S39

Ranger Project
lunar photographic techniques and results H04
impact of mission results on future lunar exploration S32
use of computers to maximize information retrieval from *Ranger* pictures S32
Ranger IX flight path determined from tracking data V02

Safety Engineering
safety equipment for handling 20- and 5-kW arc lamps A04

Scientific Instruments
Surveyor scientific instruments L05
S22
S36
S37
S38
S39
S40

Subject	Entry	Subject	Entry	Subject	Entry

Scientific Instruments (contd)

Mariner Venus 67 scientific
instruments M02
M03

performance of breadboard
electronics system developed for
Lunar Orbiter gamma ray
spectrometer M11

application of minimization
computer program to design of
curve function generator for
mass spectrometer for proposed
Mars probe R13

Mariner Mars 1964 scientific
instruments S18

experimental and theoretical
comparison of JPL active cavity
radiometric scale defined by new
active cavity radiometer and the
international pyrheliometric
scale W06

Soil Mechanics

correlations between multispectral
microwave brightness
temperatures and geologic
parameters B17

physical properties of soils of
desert regions C01

Surveyor III and *VII* soil
mechanics/surface sampler L05
S37
S38
S39
S40

proton-bombardment-induced
target temperatures and thermal
accommodation coefficients of
rock powders N02

pyrolysis–gas chromatography–mass
spectrometry system for possible
use in organic analysis of
Martian soil S13

Sterilization

standards for Mars and Venus
space-vehicle sterilization C11

JPL sterilization assembly
development laboratory G02
R02

ethylene-oxide–Freon 12
decontamination and dry-heat
sterilization cycles K01

Structural Engineering

structural analysis and matrix
interpretive system application...B05

measurement of structural transfer
functions significant to *Surveyor*
spacecraft flight stability G03

analysis of space vehicle structures
using transfer-function concept...H05

Structural Engineering (contd)

receptance coupling of structural
components near a component
resonance frequency L14

Mariner Venus 67 spacecraft
structure M02
M03

lightweight aeroshell for possible
use in containing science payload
to be landed on Mars N01

variations in weight and
performance characteristics of
large-area solar arrays O02

Surveyor spacecraft structure S36
S37
S39

Sun

solar proton events and associated
time-integrated proton flux
forecast during *Mariner V*
mission G06

solar wind interaction with Venus,
as determined by *Mariner V*
spacecraft M03

solar eclipse by earth, as photo-
graphed by *Surveyor III*
spacecraft R03
S35
S40

Mariner IV solar occultation
experiment R04

solar corona, as photographed
by *Surveyor* spacecraft..........S38
S40

solar constant and spectral dis-
tribution measurements using
JPL active cavity radiometric
scale W06

Surveyor Project

television pictures B13
B14
B15
H04
R03
S35
S38
S40

measurement of structural trans-
fer functions significant to
spacecraft flight stability........G03

electromagnetic compatibility
program J03

spacecraft flight paths determined
from tracking data.............L02
O03
T03

scientific instruments and results....L05
S38
S40

Surveyor Project (contd)

spacecraft testing at JPL environ-
mental test laboratory..........O04

spacecraft launch dynamic
environment P02

television camera used as a
scientific instrument S22

impact of mission results on
future lunar exploration S32

mission descriptions and
spacecraft performance S36
S37
S39

Telemetry and Command

unified S-band receiver–exciter
subsystem used for *Apollo* mission
two-way communications B22

synchronization of pulse-code-
modulated channels by word
stuffing B23

cost effectiveness of spacecraft
pointing antennas D05

use of a squaring loop in a coded
or uncoded telemetry system
to generate a coherent sub-
carrier reference D06

multipath, polarization, and
pointing losses associated with
the communications link from
a planetary rough lander........F04

effect of interference on binary
communication channel using
known signals K11

Mariner Venus 67 telecom-
munications system M02
M03

Mission Operations System design
for *Mariner* Venus 67 Project...M02

Mariner V space flight
operations M03

Mariner V extended mission
operations M04

Mariner IV extended mission
operations R04

Master Data Library for
Mariner IV mission R04

digital demodulation with data
subcarrier tracking S01

Surveyor telecommunications
subsystem S36
S37
S39

Tracking and Data System and
Mission Operations System
support of *Surveyor* missions.....S36
S37
S39

high-rate telemetry system
developed for *Mariner* Mars
1969 missions T01

Subject	Entry